POWER

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FRED R. LOW, *Editor*

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An International Heat Unit

THE heat physicists who are seeking a more precise determination of the physical properties of steam, and who met in London last summer to compare and correlate their results, did one thing that will render their meeting memorable.

They adopted a unit of heat definable in terms of the simple relations of force, mass and acceleration.

We have been working with the B.t.u. and the calorie, the one involving the varying value of the pound with location, and both involving the varying specific heat of water.

The calorie as newly defined is equivalent to 1-860th of a kilowatt-hour, instead of to the amount of heat required to raise the temperature of one kilogram of water one Centigrade degree at some place or other in the scale. And it makes a difference which place.

The kilowatt as a measure of power is rapidly backing the horsepower, cheval, Pferde-stärke, etc., off the map. Although it has come into use largely in connection with electrical machinery and applications, it is not electrical but mechanical in its derivation, definition and significance.

One-860th of a kilowatt-hour represents a definite amount of energy whether it be applied as mechanical work to lifting water and creating pressure head or as heat to accelerating the molecules of a substance and creating temperature head.

Its adoption as the measure of the value of a calorie means the doing away with the necessity of laboratory determination in favor of expression in established physical units. And it means the passing of the "mechanical equivalent of heat" as an experimental relation between two independent units of energy.

The equivalent value of the B.t.u. is 778.3 foot-pounds, which is about as accurate as it has been possible to determine it experimentally.

If the absolute watt-second were used instead of the international, which differs from it by about 1 in 3,000, the corresponding value of the B.t.u., as pointed out by Dr. Mueller of the United States Bureau of Standards, would be an even 778.

While less awkward divisors than 860 and 778 might be chosen in establishing a new unit, the conference at London was not establishing a new unit but precisely defining an old one.

The convenience attending the practical correspondence of the B.t.u. and the calorie to unit temperature change in unit mass of water will doubtless lead to a long continuance of their use. For laboratory purposes the joule, which is one watt-second, or 1-1000th of a kilowatt-second, is finding increasing use, bringing into practical application the natural unit for the mechanical equivalent of heat which bears the name of one of the first to determine its approximate value.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Tuning Up the Industrial Machine

"THE greatest tool our economic system affords for the establishment of stability is the construction and maintenance work, improvements and betterments and general clean-up of plants in preparation for cheaper production and the increased demand of the future." These are words of an engineer; they are taken from President Hoover's address before a conference of business leaders on Dec. 5. The same address ends thus: "I have no desire to preach. I may, however, mention one good old word—work."

Business, as has been clearly shown in the Washington conferences, is fundamentally sound. A slight falling off in the consumption of luxury goods by those hit in Wall Street can have little direct effect on industry in general. For this, compensation more than ample can be provided by the simple process of diverting a certain amount of labor to additional programs of new building, modernization and general cleaning up. With wages maintained, employment normal and the usual volume of industrial and private buying, business will sail on an even keel.

A few weeks back there was a possible danger that mob psychology would lead to a general falling off in buying that would start the vicious circle of less employment, less spending and consequent falling production.

It is fairly clear now that the common-sense doctrine of work, with spending as usual and modernization programs to take up the slack, will prevail. Thus prosperity will be maintained while the mechanism of industry is being tuned up for a not-distant advance to new productive levels.

Condenser Cleaning

KEEPING condenser tubes clean is a problem of varying magnitude. In some plants it is almost negligible, while in others, where frequent cleaning is necessary, it constitutes a constant source of worry.

So far the cleaning methods that have been developed require a complete shutdown of the generating unit, or, where design permits, a partial shutdown of the condenser, with the unit operated at light load. This condition hinders operation, and the outage of generating equipment may require the installation of additional capacity.

Few engineers know how much condenser cleaning costs or, if they do, have made a study to determine the most economic frequency of cleaning. Such a study requires that the cost of cleaning and machine outage be balanced against the savings in steam consumption due to improved vacuum.

In this number of *Power* is a report of tests made to determine the effectiveness of a condenser cleaning method that does not require a shutdown of the condensing equipment. Should this prove as successful as these preliminary tests indicate, with other water conditions, it may be expected that the method will become popular with power engineers.

A Full-Time Federal Power Commission

IN President Hoover's recent message to Congress considerable attention was given to problems associated with water-power development. Among the features considered was the present membership of the Federal Power Commission, which now consists of three Cabinet officers. The responsibilities of the commission have increased to where they far exceed the time and attention that these officials can properly spare from other important duties. The President recommends that authority be given him to appoint a full-time commission to replace the present members. If this suggestion is carried into effect it will be another constructive move toward making the Federal Power Commission the agency it should be in the development and control of the nation's water power.

The administration of the Federal Water Power Act has too long been a step-child depending upon the charity of officials having other important responsibilities. Up until about eighteen months ago the commission had no personnel other than that which it could borrow from three departments of the government. This condition existed notwithstanding that the fees collected in the administration of the act were sufficient to make its work self-sustaining. To a degree, that fault has been corrected, but the commission is still inadequately constituted to properly handle its many duties.

Responsibilities have arisen in the administration of the Federal Water Power Act that did not exist, or at least did not attract serious attention, when the act was passed by Congress in 1920. For a period after the act became law it appeared that means had been provided that would encourage rapid development of the nation's water power. True, much progress has been made, but there have arisen many conflicting interests on rivers where power may be developed. All of these

have greatly increased the responsibilities of those charged with the administration of the government's interests in these developments. The regulation of construction costs, the auditing of pre-license costs, the lack of state laws to exercise the necessary control over water-power development—these factors and many others have increased the work of the commission and added to the complication of carrying into effect the purpose of the act.

Water power is one of the nation's most valuable natural resources, and the only one that remains in public control. Congress passed the Federal Water Power Act after many years of controversy, with the object of protecting the public's interest in the nation's water powers and encouraging their development. Nevertheless, Congress has never provided suitable means for administering the act. As a result, water-power development has frequently been retarded instead of encouraged. If the President's recommendations are carried into effect, the appointment of a full-time commission will do much toward improving the administration of our water powers.

Reason in All Things

IN MANY circles strenuous objections are being raised against air pollution and noise. Some of these are well founded; some are not. Now and then such sentiment results in stringent legislative requirements that are most difficult to meet, or lawsuits follow in which exaggeration of the facts are alleged. Engineers, having a better grasp of the industrial aspects of this matter, should definitely take the lead in such activities, and should ever be on the alert to nip in bud ill-considered attempts to require the impossible.

For one thing, much soot arises from the small household chimney. Also the conduct of industry necessarily entails some unpleasantness. It is impossible to strike the anvil without some noise; it is impossible to burn fuel without occasional smoke; it is difficult to handle some materials without dust; and so on. But there is in every case a difference between care and carelessness—between intelligent control and utter neglect.

The public is justified in insisting upon the exercise of intelligent care. It is not justified in asking for the impossible or the infeasible. And right here the engineer should be on the job to see to it that the public likewise exercises intelligence and reasonable consideration for the difficulties of the other fellow. It is easy to pass laws condemning the blacksmith to jail because his anvil rings, or fining the power plant because coal dust blows from its storage pile; but it may be unreasonable to demand that the smith install a forging press, or that the coal user build a house to cover his coal pile.

Let there be reason in all things, on both sides, and let the engineer keep his eyes open and his wits active to promote the reign of reason both in the conduct of industry and in the demands of the public.

Accessible Piping An Aid to Operation

REFINEMENTS in power plant heat balance and duplication of piping considered necessary to insure continuity of operation have resulted in the complex piping systems found in modern power plants. Unless this piping is carefully designed, not only is normal operation difficult, but proper and speedy action by operators during an emergency is greatly hindered.

Complex piping arrangements may result in the closing or opening of a wrong valve causing a station shutdown, and delayed action caused by inaccessibility may result in damage to equipment. Crowded piping may also increase the cost of maintenance, because of the longer time required to complete repairs under such conditions.

The importance of these considerations is indicated by an article in this number of *Power* describing the principles and methods followed in laying out the piping system for the Delray station, recently placed in operation. Necessarily complex piping has been simplified for the operator by neat arrangement and standardization. Accessibility, secured by the use of plant models, and nameplates on all valves has done much toward making operation easy and therefore permit more time to be given to those details that improve economy.

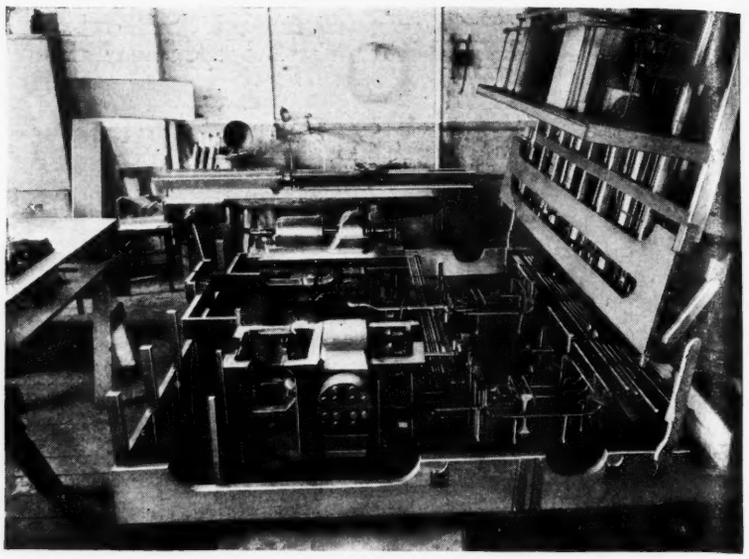
Painting the piping in colors such as suggested by the A.S.M.E. code, and the use of diagrams in the same colors will also be found to greatly aid the operators, in definitely fixing in their minds the respective layouts—a picture which is necessary to both normal and emergency operation.

We Congratulate Mr. Stetson And the A.S.M.E.

AS ANNOUNCED in this number, George A. Stetson has been appointed editor-in-chief of *Mechanical Engineering*, the monthly publication of the A.S.M.E. He will also be in responsible charge of the *Transactions* and the *A.S.M.E. News*. *Power* extends congratulations to the man and to the institution.

Mr. Stetson's fitness for this important position has been demonstrated beyond question. He combines to a rare degree the qualities of engineer, writer and editor. With them go a breadth of interest and a richness of personality that have endeared him to a wide circle of friends.

In *Mechanical Engineering* and the other A.S.M.E. publications Mr. Stetson finds an opportunity worthy of his best efforts. To serve as a clearing house for the vast activities of the A.S.M.E., to disseminate information and guide engineering thought, to interpret mechanical engineers to themselves and to the public—these are important editorial tasks. Under the leadership of George Stetson their continued successful accomplishment is assured.



Model of plant, showing the condensers and piping for two units

Models *Make for* Accessibility IN DELRAY PIPING

By Frank Thorp
and
R. M. Van Duzer, Jr.
Technical Engineers, Detroit Edison Company

DELRAY power house No. 3, the sixth central station to be placed in service by the Detroit Edison Company, is so designated because it adjoins the two older plants in the Delray industrial district of Detroit. It is designed to contain six, possibly seven, 50,000-kw. turbine-generators and the corresponding boiler capacity. Two units and five boilers are now installed in the first section of the plant, and a third unit is on order for delivery in 1931. It is possible that the last four main units may be larger than now contemplated, as the building and foundations are adequate to allow such a change. There are two 4,000-kw. auxiliary turbine-generators in service, which supply the house-service demands. The steam pressure is 400 lb. gage at the boilers (throttle pressure 375 lb.), and the steam temperature is 700 deg. The boilers are of the Stirling type, fired by underfeed stokers. Descriptions of these features of the plant appeared in *Power*, Nov. 5, 1929.

In large power plants the piping has become very complicated, notwithstanding many attempts to simplify it. Continuity of service seems to require elaborate valving arrangements and duplication of portions of the piping systems; higher steam temperatures require more elaborate provisions for flexibility; and refinements in plant design call for an increasing number of different piping systems. At Delray there are nineteen separate major systems of piping, not including vents and overflow lines.

The piping at Delray does not show any radical departures from recognized practice or from that in the company's previous similar plants, but it does represent a serious effort on the part of the designing staff to follow certain principles that were established as a result of experience in the design and operation of previous plants.

Two paramount objectives were established in addition to the ordinary elementary considerations. One of these was to arrange the piping in as neat and orderly a manner as possible to produce a finished ensemble that would be pleasing and workmanlike in appearance and at the same time be accessible and easy to operate.

The second objective had to do with the plant layout in general as well as with piping. The Delray plant is planned for seven main turbine units, which it is expected will be identical in every respect. There will be three in the first section, and the others will be added from year to year as required. If experience and the advance of the art should lead to changes in the design of these future turbines or their auxiliaries, then it is contemplated that such changes will be made in the existing units as well, if they are not too costly.

Standardization and duplication of apparatus have been found to be of great practical value, and it was desired that this idea of duplicated arrangement be carried out to the fullest possible extent, not only as to the design and locations of the major equipment, but also as to layout of the piping. Thus each pair of main turbine units and their bleeder heaters, evaporators, hot-well pumps, boiler-feed pumps and oil coolers are arranged as a standard group, repeated with practically no changes throughout the plant. What is more, the piping serving each group is identically arranged, each valve, for example, being in the same corresponding position in every

main unit group. Lack of uniformity in the spacing of the building columns and of the auxiliary turbines with respect to the main turbines made it impossible to carry out this principle completely, but it has been followed to a large degree. As a result, the necessarily complicated valving arrangements are easily learned and kept in mind by the operators, and largely because of this it will be possible to operate the main units and their auxiliaries with a relatively small number of men.

In the boiler house the same idea of identity of arrangement is followed, but here the problem was much simpler. The boilers are located in two rows facing a common firing aisle, and the same piping layout is used for each boiler, with the exception that in some respects the piping serving opposite boilers is of opposite hand.

Design Methods

Carrying out these two principles called for design methods that, while perhaps not particularly new, had not been used on previous company projects, largely because the time schedule did not permit them. In the case of Delray, the project was authorized sufficiently in advance of the date set for completion to permit ample time for refinements in design.

Piping arrangements were considered in the earliest stages of the plant design, beginning with the establishment of column centers and floor elevations. Spaces were allotted for the important systems, and a general conception of the piping as a whole was arrived at before the actual plant design had progressed very far.

Complete assemblies of all of the piping systems in the plant were made before the detailed design of any one system was begun. This might appear to be the obviously correct method, but heretofore lack of time made this practice physically impossible. The assemblies were based on carefully considered diagrams of each piping system.

The exact arrangement of all of the auxiliary equipment was considered from a piping standpoint, and, in fact, the locations for most of the equipment actually were chosen by the piping designers.

Particular attention was paid to appearance, accessibility and to what might be called the architecture of the piping. To further this end a rather complete model of the plant was built to a scale of $\frac{1}{2}$ in. per foot, with the piping represented in wax. This modeling method had been developed for previous projects,[1] and the technique had been worked out so that for this job it was possible to represent quickly on the model each system of piping as it was designed. The designers were thus enabled to visualize its actual appearance. The cost of the modeling is amply justified by the better piping work that resulted.

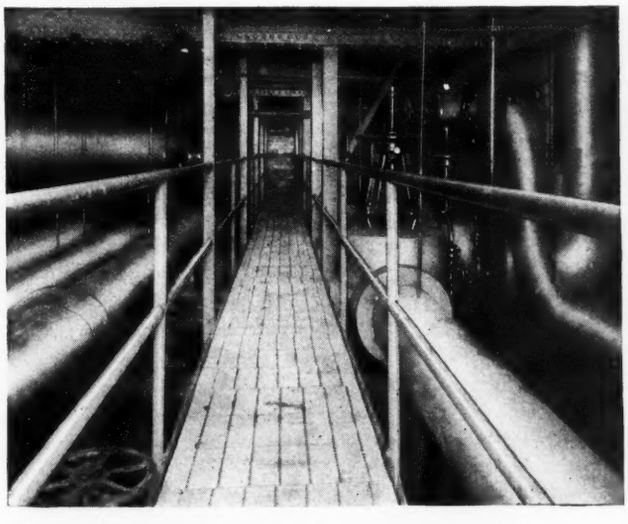


Fig. 1—Header valves made accessible from walkway

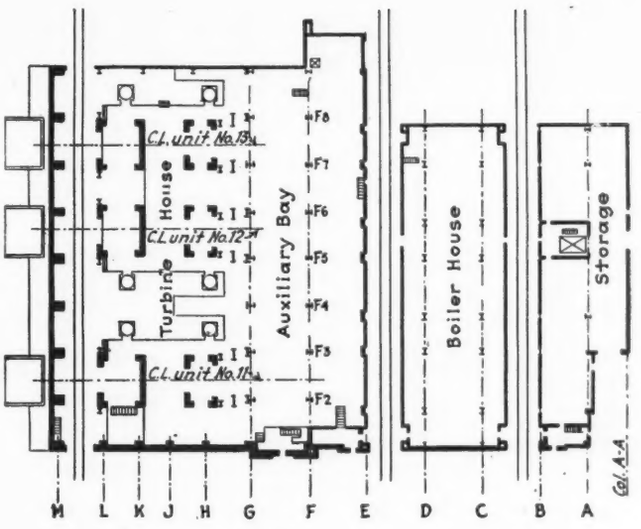


Fig. 2—Basement floor plan, with column locations

A portion of the model in the process of construction, showing the condensers and piping for two main units, is shown on the opposite page. It should be borne in mind that the object is not to produce a finished model of the plant, but to provide an aid to the designers.

The piping arrangements have been simplified to some extent by the location of the column centers. Fig. 2 shows the basement floor plan with the column locations. It was not possible to have the longitudinal spacing of the even-numbered column rows the same in the boiler house as in the turbine room, because of the space requirements of the boilers. However, the odd-numbered rows of columns were set on the same transverse center lines. The idea was to provide as clear a space as possible for the transverse pipe lines and to avoid numerous offsets in these lines due to column interference.

In the early stages of the design, definite spaces were alloted to the piping, and nothing else was allowed to encroach upon these spaces without careful consideration and approval of the piping designers. All of the longitudinal headers running north and south through the turbine room basement were placed in one horizontal plane, 11 ft. above the floor. The transverse lines were placed in a plane 9 ft. above the floor, while all of the main vertical risers were placed in space allotted for their use.

These different space allocations are shown in Fig. 3. In the space marked No. 1 are the headers serving the main turbine-generators, such as condensate, sealing water, priming, etc. The headers serving the entire plant, such as air, building-heating steam, general service water, oil, etc., were placed in space No. 2. The cross-connecting piping was placed in space No. 3. Space No. 4 was set aside for all of the vertical risers that could be brought to this point. It was not possible or feasible, however, to bring a few of the vent and drain lines to this location in the building.

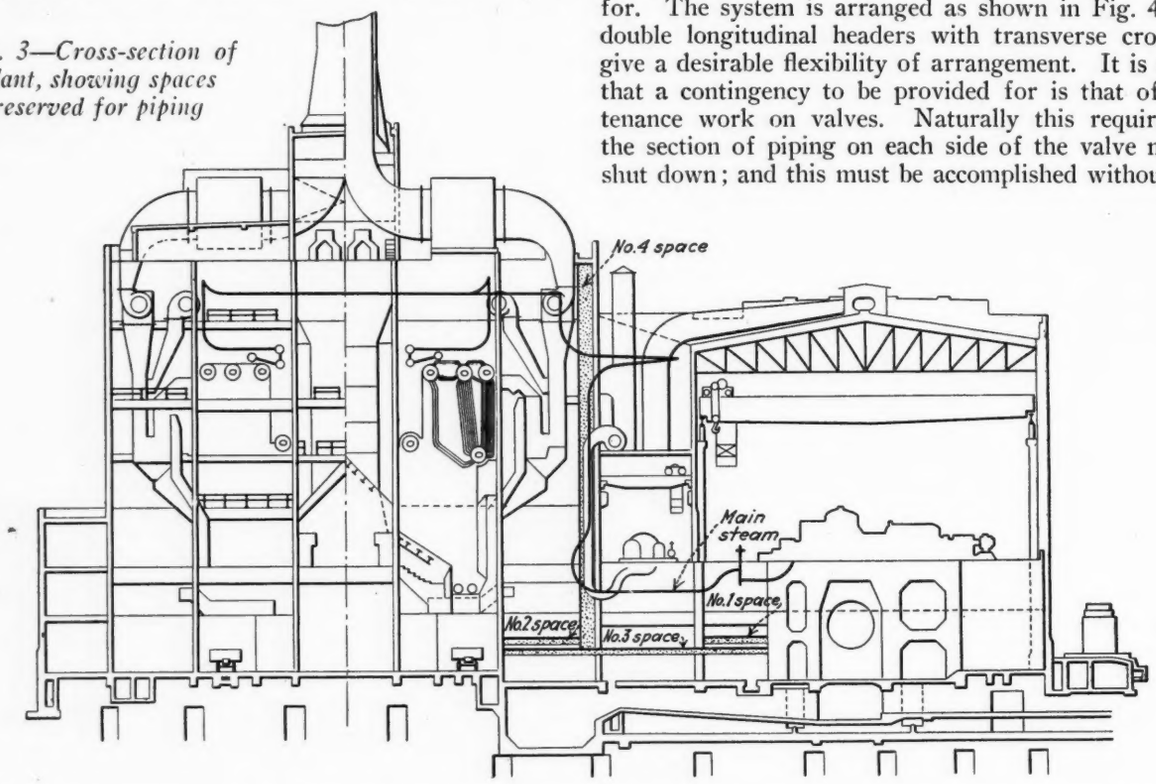
All of the valves on the headers in space No. 2 have

[1] See "Modeling as an Aid in Power Plant Piping Design," by C. T. VanDusen, Feb. 23, 1926, *Power*.

been made accessible by placing a walkway parallel to this group of lines. Fig. 1 shows a view of the walkway looking north. By this arrangement the operation and maintenance of these valves has been made more convenient for the operators.

A neat and unified appearance has thus been given to the piping in the turbine room basement by the grouping

Fig. 3—Cross-section of plant, showing spaces reserved for piping



of the header systems and by adhering to the 9- and 11-ft. elevations for the transverse and the longitudinal pipe runs. The four groups of piping can be seen on the model.

A complication in the layouts was introduced by the need of arranging the main unit condensers right- and left-handed. In general, it has been found more desirable in a repeating arrangement of units, such as the main turbines, not to use a right- and left-hand arrangement, but much economy of building space is gained by the use of a common light well giving access to two condensers. Consequently, the condensers and their immediate auxiliaries (circulating pumps, etc.) are in pairs, right and left hand, but the remainder of the equipment is not so arranged.

Between turbine units the wide spacing is 76 ft. and the narrow spacing is 24 ft., making the total of a wide and narrow space, 120 ft. This total is a multiple of the 24-ft. spacing of the columns on the *H* and *G* rows. The object of this spacing was to keep the center lines of the turbines as uniform as possible in relation to the *H* row of columns.

Important piping systems upon which the continuous operation of the plant depends have been designed so that a failure of a certain section will not cause the shutdown of more than one piece of major equipment. The maintenance and repair of the lines and valves also has been facilitated by this arrangement.

As the main steam piping is of prime importance in any plant, it was given much study. For several years investigations of expansion stresses and of pipe flexibility have been made by the company's engineers, and the steam piping in its recent plants has been designed rather liberally from this standpoint. The net result has been the absence of trouble in the newer plants from leaky joints due to expansion strains and of troublesome thrusts on turbine throttles.

Elementary considerations of continuity of service made it evident that a double-header system was called for. The system is arranged as shown in Fig. 4. The double longitudinal headers with transverse crossovers give a desirable flexibility of arrangement. It is evident that a contingency to be provided for is that of maintenance work on valves. Naturally this requires that the section of piping on each side of the valve must be shut down; and this must be accomplished without causing the simultaneous shut down of several boilers and main turbines and without isolating portions of the system. Study of Fig. 4 will show that these conditions have been met.

Double valving was resorted to in order to prevent leakage while a line was being repaired, and also to keep a leaky valve from becoming worse by the continual passage of steam. Remote-controlled motor-operated valves have been installed on the turbine and boiler leads to be used in case of an emergency. The control panel for these valves is located in a part of the plant that should not be affected by any serious trouble.

In working out the arrangement of the piping, considerations of flexibility played an important part. The horizontal thrust on the turbine throttle flange was to be kept, by specification of the turbine manufacturer, to not more than 1,000 lb. The maximum fiber stress in the piping was to be kept down to approximately 10,000 lb. per square inch. The first of these requirements was easily met, because the main headers are on the pipe gallery floor near the roof of the boiler house, and the turbine leads are, therefore, long and flexible. The expansion of the headers and of the boiler had to be provided for. Although the piping is flexible, there has been little additional length used to provide this feature.

Pipe sizes were arrived at largely from the standpoint of pressure drop. Several hypothetical conditions were assumed, involving certain boilers and turbines in operation. The pipe sizes were selected so that the pressure drop under the worst of the assumed conditions would be of the order of 30 lb. per square inch from the superheater stop valves to turbine throttles. The steam veloc-

ities thus produced are from 10,000 to 13,000 ft. per minute.

The auxiliary superheated steam header, which is located in the turbine-room basement, is supplied by piping connected at the points indicated in Fig. 4, each connection having a combination stop and check valve to prevent back flow into the main system from the auxiliary system.

Steam leads to the auxiliary turbine-generators are taken from manifolds in the header. Each of these manifolds is supplied with steam from two directions, so that if one source is cut out there is still a supply available. Steam is also taken from the same source for other auxiliary steam-driven equipment.

Boiler feed water is supplied from two headers, the main system for normal use and the auxiliary system for service in case trouble should develop in the main header. These two lines are above the main steam headers in the pipe gallery.

A centralized location of all boiler feed control valves was arranged at each boiler. The valve nests are arranged at the ends of the coal bunkers, the groups for the east row of boilers being on the south side of each bunker, while the groups for the west row are on the north side. This arrangement is ideal for the operator who is tending water, as the valves are accessible and are identical in layout for each boiler. All of these groups of control valves for the five boilers now installed are located within a space of 75 ft. Fig. 5 shows the valving combination for No. 5 boiler.

The main general service water header is also protected by an auxiliary header that can be used in case of trouble.

On all of the fittings and valves the flanges conform to the A.S.A. standards. No new types of joints were used on any of the piping systems. The ordinary Vanstone lap joint for the high-pressure steam and boiler-feed lines, and the screwed companion flange joint for the lower-pressure lines have proved satisfactory in past installations. The table contains a list of the different standards and valve selections used in the various piping systems.

Much study was given to the valve selections, in order to decrease the number of different types and makes. In the company's other plants there is such a variety of valves that it is necessary to stock a large number of different makes for spares.

Good general appearance and neatness of the small lines, which it was not possible to show on the general assembly drawings, were obtained by having them installed under the direction of field men who were familiar with the underlying design principles. All of the pipes have been run parallel to the axes of the building wherever possible. The use of 45-deg. and similar fittings was discouraged in all of the layouts except the building drainage system, where it was a code requirement.

An endeavor was made to keep from placing valves and fittings above any electrical apparatus. Where it was not possible to do this, the equipment is protected from possible leaks by the installation of permanent metal covers.

Welded joints were used to assemble certain of the piping systems. Plain butt welds made with the electric arc have been the only type of joint used. In no case have joints been welded where a failure will mean the crippling of equipment or endangering of life. The compressed-air system, the heating-steam header, part of the oil lines, part of the general-service water system and all vent piping, excepting the vent lines from the boiler safety valves, have been welded. Tube turns were used in assembling some of the welded lines, giving them a neat appearance.

It is the company's policy that welding will not be used on any piping system of major importance until some practical field method for the testing of welds nondestructively is developed. Past experience has shown that the human element in welding cannot as yet be eliminated. The lack of ductility in welds produced by

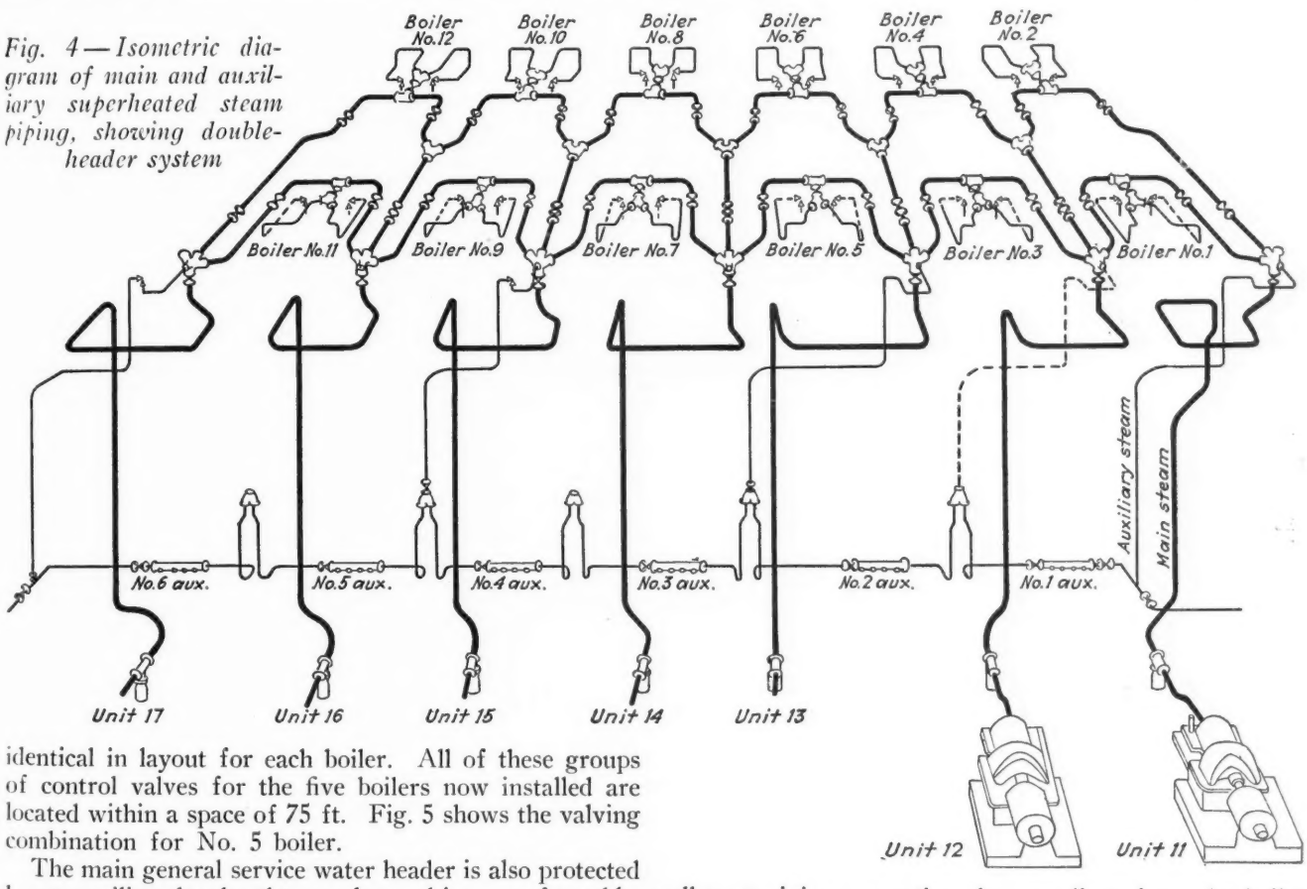


Fig. 4—Isometric diagram of main and auxiliary superheated steam piping, showing double-header system

ordinary field methods is also regarded as objectionable.

A number of steam traps were eliminated by using orifice plates that give a continuous blow. These plates consist of a $\frac{3}{4}$-in. blind flange with a $\frac{1}{16}$-in. hole in the middle, with bolt holes drilled to conform with the flanges on the drip lines between which they are placed. They are installed so that they can be cut out of service and taken apart for regular inspection, and are being used to drain the extraction steam piping and casing drip lines on the main and auxiliary turbines and certain parts of the main superheated steam system. This method is desirable particularly for drains that are not used frequently.

It is too soon to comment on the operation of the Delray piping or to get the opinions of the operators directly in charge, as the plant has been in service for only a short period. A few minor changes, such as the rearrangement of some of the drip piping, have been necessary. There have been no major difficulties, and it is not thought that any will develop later on.

No costs are available for comparison with previous installations, but considerable saving will be realized on the design and engineering of the piping for the coming additions, because of the almost exact duplication of the piping. As an example of this saving, the drafting room man-hours required for the piping drawings of the third Delray unit will be about one-sixth of that required for a similar unit soon to be installed in another plant where it was not originally contemplated.

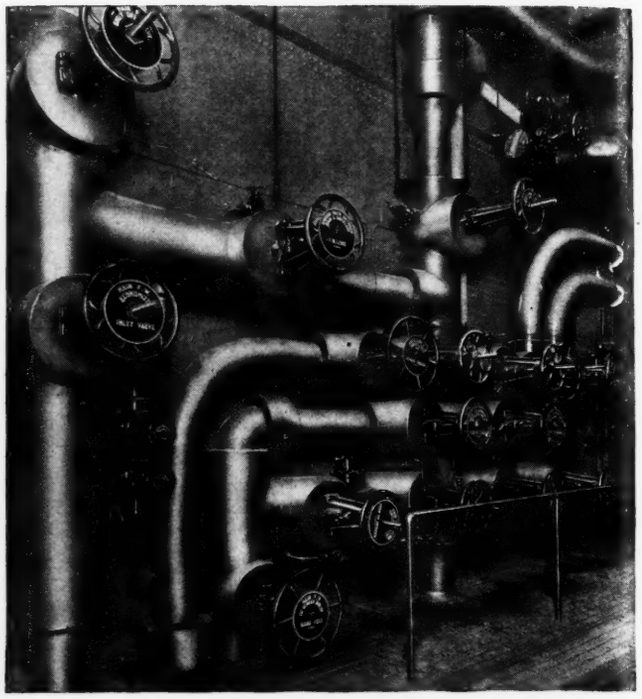


Fig. 5—Typical grouping of boiler-feed control valves arranged at the end of the bunker

Piping Standards and Valve Selections, Delray Power House No. 3

Piping System	Piping Standards: Valves, Fittings, Flanges	Piping Standards: Pipe	Joints	Valve Selections
Boiler connections Economizer connections Main superheated steam Aux. superheated steam Saturated steam Main boiler feed Aux. boiler feed Boiler blowoff High-pressure drips Boiler water columns	A.S.A. 600 lb W.S.P.	4 in. and larger A.S.A 400 lb. W.S.P. seamless. 3 in. and smaller A.S.A. 600 lb. W.S.P. seamless	4 in. and larger Vanstoned. 1½ to 3 in. screwed steel companion. Flanges: ¼ in. raised faces on valves, fittings and screwed steel companion flanges. All contact faces serrated. 1½ in. and smaller screwed joints	Chapman Valve Mfg. Co. parallel slide gates. Size 3 to 16 in.—Nitralloy seats and disks. Chapman Valve Mfg. Co. flanged, wedge gates Lunkenheimer Co. flanged globes—sizes 2½ in. and larger. Chapman Valve Mfg. Co. flanged swing checks J. Hopkinson & Co., Ltd. parallel slide boiler blowoff valves. Consolidated Ashcroft, Hancock Co., Inc.—screwed and flanged globes in sizes ½ to 1½ in. and some 2 in. Monel seats and disks or equivalent
Fourth-stage bleeder steam, 4,000-kw. unit	A.S.A. 250 lb. W.S.P.	Standard weight steel	Vanstoned	Chapman Valve Mfg. Co. wedge gates steel.
Exhaust, high-pressure seals, 50,000-kw. unit	A.S.A. 150 lb. W.S.P.	Standard weight steel	Vanstoned or screwed steel companion flanges welded at the hub	Chapman Valve Mfg. Co. wedge gates steel
Bleeder steam, 9th stage, 50,000-kw. unit	A.S.A. 250 lb. W.S.P.	Standard weight steel	Vanstoned or screwed steel companion flanges welded at the hub	Chapman Valve Mfg. Co. wedge gates steel.
Bleeder steam, 13th, 16th and 19th stages, 50,000-kw. unit Exhaust from turbine to main condenser, steam-driven boiler-feed pump Vacuum, main condenser to dry vacuum pump Condensate, hot-well pump suction	A.S.A. 125 lb. W.S.P.	Standard weight steel	Vanstoned or screwed steel companion flanges welded at the hub	Chapman Valve Mfg. Co. wedge gates steel. Crane Co. globe valve, wedge gates steel. Lunkenheimer Co. flanged wedge gates, I.B.B.M.
Condensate, all other General service water Low-pressure drips City water	A.S.A. 125 lb. W.S.P.	Standard weight steel Standard weight steel Standard weight steel Standard weight steel—galvanized	4 in. and larger flanged, screwed cast iron companion flanges 3 in. and smaller screwed	Lunkenheimer Co. flanged wedge gates, I.B.B.M. Walworth Mfg. Co. screwed brass gates and globes. Lunkenheimer Co. screwed brass checks.
Oil	A.S.A. 125 lb. W.S.P.	Standard weight steel	Flanged or screwed in all sizes. Some pipe joints buttwelded	Chapman Valve Mfg. Co. flanged wedge gates. Crane Co., screwed rising stem gates.
Exhaust lines to atmosphere Safety valve vents—boilers Compressed air	A.S.A. 125 lb. W.S.P. A.S.A. 125 lb. W.S.P. A.S.A. 125 lb. W.S.P.	Standard weight steel Standard weight steel Standard weight steel	Welded Flanged Welded, flanged and screwed	Lunkenheimer Co. flanged wedge gates, I.B.B.M.
Instrument, high temperature	A.S.A. 600 lb. W.S.P.	A.S.A. 600 lb. W.S.P. seamless	1½ to 3 in. screwed steel comp. flanges. ¼ in. raised faces—serrated	Consolidated Ashcroft, Hancock Co., Inc. screwed globes.
Instrument, high pressure, low temperature Instrument, low pressure, low temperature	Brass—600 lb. Service Brass—125 lb. Service	Copper tubing Copper tubing	Screwed Screwed	Brass.

Atmospheric relief valve on main 50,000-kw. unit, 48 in. Chapman Valve Mfg. Co.
Atmospheric relief valve on aux. units—18 and 10 in.. G. M. Davis Regulator Co.
Condensate return traps from bleeder heaters..... G. M. Davis Regulator Co
Circulating water to condenser—48 in., hydraulically operated..... Chapman Valve Mfg. Co.

CHLORINATING Circulating Water

Keeps Condenser Clean

By V. M. Frost and W. F. Rippe
Public Service Electric and Gas Company

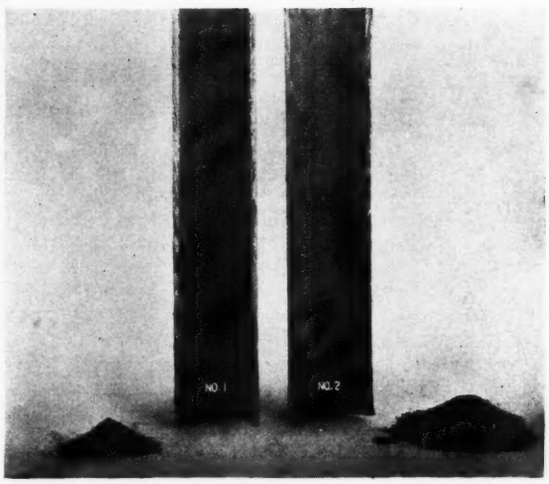


Fig. 1—Tube No. 1 from condenser chlorinated, tube No. 2 from condenser not chlorinated

IN AN endeavor to better the heat transfer and reduce the cost of cleaning condensers in the power stations of the Public Service Electric & Gas Company, it was decided to experiment with chlorine gas for treating the circulating water. A co-operative arrangement was made with Wallace & Tiernan Company, specialists in the application of chlorine control apparatus, to try out the method at the Kearny (N. J.) station.

Kearny station is located on the west bank of the Hackensack River about 1½ miles from Newark Bay. Slime troubles seriously affect the vacuum obtainable in the condensers, and it is necessary to clean the condensers with rubber plugs at least once a week in the warm weather and twice a month in mid-winter. Various methods of brushing and boiling the tubes are also used to improve the heat transfer. These methods though not entirely satisfactory were the best available.

Samples of the river water were taken every two hours, and analyses of the samples were made by the Department of Sewage Disposal, College of Agriculture, New Brunswick, N. J. The averages of some of the more pertinent items in the reported analyses are:

Total solids, parts per million	19,410
Suspended solids, parts per million	52
pH	7.2
Chlorides, parts per million	9,550
Common salt, parts per million	15,760
Dissolved oxygen, parts per million	1.0

It can be seen from the low oxygen content that the water is very much polluted. The salt content indicates about one-half sea water.

The condensing equipment at Kearny consists of five 50,000-sq.ft. condensers. They are of the two-pass type, with vertically divided water boxes, and each has 10,000 one-inch tubes of No. 16 gage Admiralty mixture 19 ft. 2½ in. long. Each condenser is provided with two single-speed circulating pumps of approximately 45,000 g.p.m. capacity, so connected that one pump can supply either half or all of its own condenser, or of any other condenser in the station. During normal operation with relatively cold water each condenser is operated individually with one of its own pumps.

No. 4 unit was arbitrarily chosen for the chlorinating experiment. This unit, which is the same as No. 2 in every respect, consists of a 47,250-kw. Westinghouse turbine generator unit and a Westinghouse radial-flow condenser equipped with two steam-jet air pumps and one hydraulic air pump. Since these two units are identical in every respect and operate under practically the same load conditions, comparison of the condenser operation will indicate the effectiveness of the chlorine cleaning.

After deciding on what unit to install the equipment, the next question to come up was where to put the equipment. The choice lay between injecting the chlorine in the canal at the screen or in the suction pipe of the pumps. It was finally decided to install the equipment in the screen room and inject the chlorine solution immediately behind the screens, for the following reasons:

1. The chlorine apparatus is kept out of the heart of the plant, as it is a hazard.
2. Due to the comparatively small suction chamber and to isolation of the units, there would be no appreciable dilution.

Keeping condensers clean is, in many power plants, a major operating problem. How chlorine prevented the formations of slime on the condenser tubes at Kearny is told in this article, which is an abstract of a paper presented at a meeting of the metropolitan section of the A.S.M.E., on Nov. 21.

This investigation is based on the theory that slime fouling of surface condensers is the result of definite biological growth and is dependent upon conditions of temperature and the presence of normal water organisms in the circulating supply. Slime is a conglomerate of inorganic matter, namely mud and silt bound together by algae

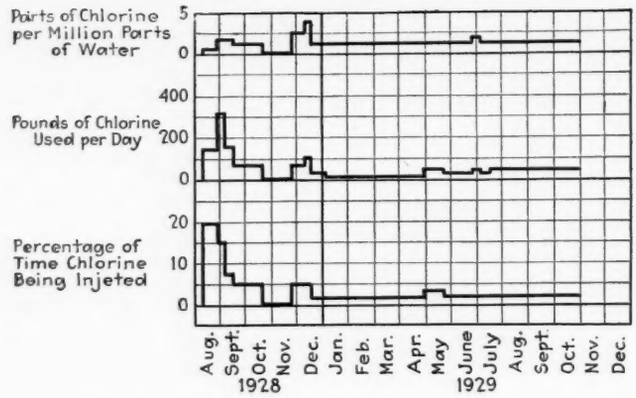


Fig. 2—Record of chlorination dosage and concentration

growths of a jelly-like nature. If the chlorine destroys the algae and prevents growth, there will be nothing to hold the inorganic matter together and the slime will be prevented. On this basis it was believed that intermittent dosage at correct intervals would prevent the growth and reduce the total amount of chlorine to be used.

The equipment installed in No. 4 screen room is shown in Fig. 3. It consists of three chlorinators, each capable of handling 720 lb. of chlorine per day with a battery of 150-lb. chlorine tanks, a program clock and the necessary pipings. The program clock controls the operation of this equipment by tripping a relay which operates a valve in the water line supplying water to the injectors on the chlorinators. The discharge of chlorine solution is carried from each machine down into the canal through a hose. The program clock can be set so as to give any desired frequency and length of dosage. The amounts of chlorine fed and the frequencies are shown in Fig. 2.

Figs. 4 and 5 give the story of the investigation. The data plotted are weekly averages of hourly readings taken over a two-year period, with corrections for slight load variations. The air leakages of both units were about the same, so this item has been neglected.

Unit No. 4 was taken out of service in January, 1928, for general overhauling, and during this period was given a thorough cleaning, so that when it went back into service, in April, 1928, it showed a better heat transfer

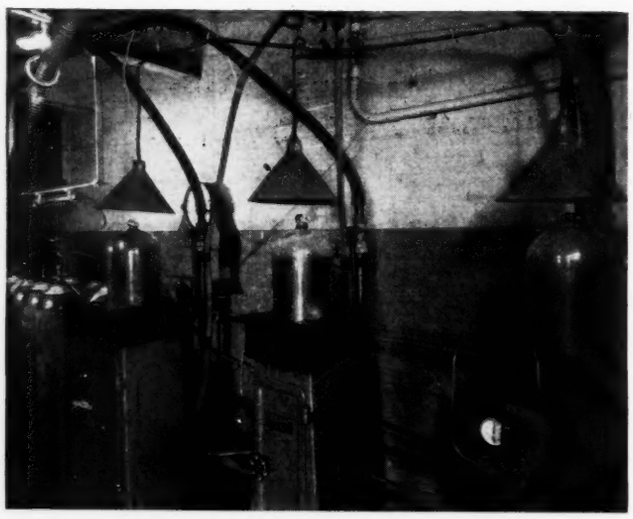


Fig. 3—Equipment used for chlorinating condenser circulating water

than No. 2. It gradually became worse, however, and by August it was about the same as No. 2. The big difference between the two units in June, 1928, was caused by tests being run on No. 4 at intentionally reduced vacuum.

Chlorination of No. 4 was started on August 10, 1928, after both No. 4 and No. 2 had been thoroughly cleaned by baking and rubber plugs. After chlorination started, the increase in vacuum of No. 4 over No. 2 was marked and frequent examinations showed the absence of slime in the tubes. This gain amounted to 0.2 in. Hg in the middle of October, 1928, but some of this gain may be ascribed to better original cleaning of No. 4 than No. 2, although it was endeavored to get both condensers in the same condition. It was not expected that there would be such a sudden gain in heat transfer, which is the reason for the foregoing statement. During this

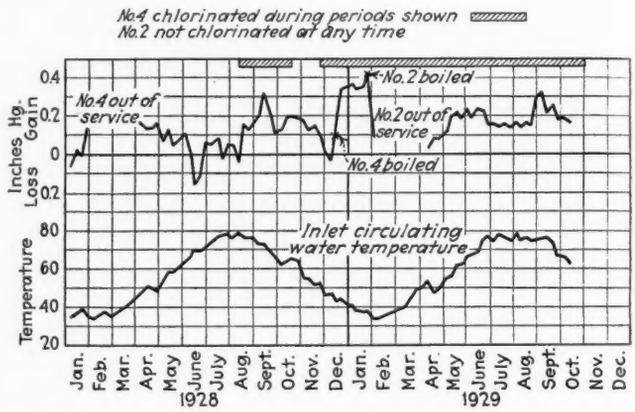


Fig. 4—Gain in vacuum of chlorinated condenser over unchlorinated condenser

period No. 2 slimed badly as usual, and even the weekly use of rubber plugs could not hold it near No. 4.

Referring to the dosage chart, Fig. 2, it shows that the amount of chlorine used per day varied from 320 pounds to 72. Due to lack of data on the intermittent method of treatment, the dosage was purely experimental. The reduction in the use of chlorine was affected by lowering the percentage of time the chlorine was being injected rather than the concentrations. At the start the chlorine was being injected for two minutes every ten minutes, but by the middle of October it was found that injection for three minutes every hour was sufficient to keep the condenser free of slime.

By October, 1928, it was apparent that the slime could be prevented, and it was decided to investigate the possibilities of cleaning a dirty condenser with chlorine. Chlorination of No. 4 was stopped on October 19, 1928, and the condenser was allowed to become dirty. Chlorination was again started on November 26, 1928, but for a while there was no apparent benefit. No. 4 became worse than No. 2, as shown in the first week of December, 1928. It is believed that the chlorine would eventually have brought No. 4 back to its original advantage, but due to its heavy accumulation of slime, it would have been a slow process. It was decided, therefore, to clean the tubes of both condensers as thoroughly as possible and to start another comparative run.

The cleaning brought the vacuum of No. 4 to a point 0.35 in. Hg better than No. 2. Chlorination was continued, with the hope of keeping the condenser as near

as possible to its condition immediately after the boiling. The advantage was increased to 0.4 in. Hg in the latter part of January, 1929, when it was decided to put No. 2 on a par with No. 4 by boiling it also, with the result that there was little difference between it and No. 4. On Feb. 1, 1929, unit No. 2 was taken out of service for annual overhauling, but the chlorination of No. 4 continued, with the idea that when No. 2 was put back into service the two units would start on an even basis. On April 10, 1929, No. 2 was put back in service with a clean condenser, and practically no difference in vacuum existed between it and No. 4.

Fig. 2 shows that from Jan. 1 to May 1, 1929, it was possible to keep the condenser free of slime with only 12 lb. of chlorine per day. This was done by operating one chlorinator for three minutes every hour for an eight-hour period each day. Here again the concentration of chlorine was maintained and the reduction in the amount of chlorine used was effected by cutting down on the percentage of time that the chlorinator was in service.

At this point, the most significant part of the entire investigation is presented, The two condensers started out on an even basis, but in a month No. 4 was 0.2 in. better than No. 2. Even though No. 2 was being cleaned regularly with rubber plugs, a gain of approximately 0.2 in. was maintained. The big increase on Sept. 1, 1928, was caused by No. 2 not being cleaned with rubber plugs for 3 weeks, but as soon as it was cleaned, it was brought down to the 0.2 in. difference again. Comparing No. 4 with other units during the period that No. 2 was out of service shows a gain of about 0.15 inch Hg.

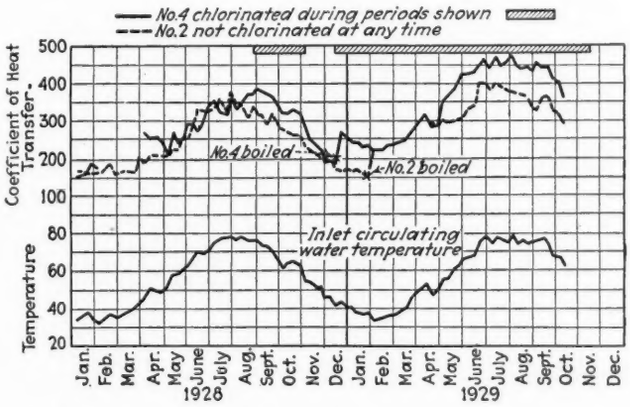


Fig. 5—Heat transfer comparison of chlorinated and unchlorinated condenser

The photograph of the half tubes shows the condition of two tubes removed from No. 2 and No. 4 condensers in August, 1929, after No. 4 had been chlorinated for one year. The piles of dirt show the relative amounts of deposits on a four-foot length.

One of the most important drawbacks of chlorinating circulating water is the fact that it is hazardous. Chlorine gas, although not poisonous, has a choking effect and will drive men out of the plant if a large enough quantity is let loose. The equipment shown in Fig. 3 has given quite a bit of trouble, especially in the early stages, due to leaks and various mechanical difficulties. Because of the nature of the gas, the policy will be to keep all future installations outside of the main building, for if a tank of chlorine were discharged in the main building it would cause a shutdown.

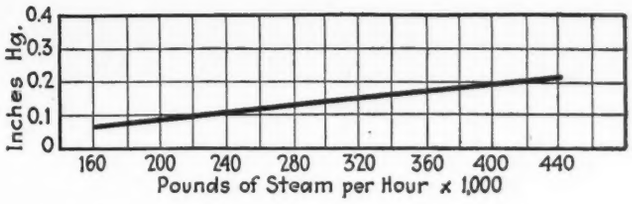


Fig. 6—Increase in vacuum after chlorination for one year

This was kept in mind when it was decided to extend the experiment to unit No. 3. The point of injection of the chlorine solution is the same as on No. 4, but the essential differences are as follows:

1. All equipment is installed in a separate building outside of the main structure. This lessens the hazard in case of leaks or failure of the apparatus.

2. One-ton containers are used instead of 150-lb. tanks. The chlorine is cheaper when bought in ton containers, and the labor involved in handling a one-ton container is less than the equivalent thirteen small tanks. Fewer connections with the ton containers lessens the possibility of leaks and reduces the labor of connecting up the tanks.

3. The chlorinator injects the solution continuously into a tower filled with limestone, and the pump operates intermittently, taking solution from the tower and pumping it into the canal. Due to continuous operation of the chlorinator less capacity is required and the chlorinators function better when in continuous service. The disadvantage is the extra pump and tower.

The question of corrosion of condenser water boxes and tubes has been brought up. There has been no sign of corrosion in No. 4 condenser after being chlorinated for a period of over a year. The amount of chlorine in the water is so small, and the time it is in the water is so short, that it is not believed any serious trouble will arise along this line. Repeated tests have usually shown no residual chlorine in the water entering the condenser and none at any time leaving the condenser during dosing periods. The maximum residual chlorine found at any time at the inlet to the condenser was 0.3 parts per million.

The amount of chlorine required for a condenser at Kearny is based on the following table:

River Water Temperature, Deg. F.	Pounds Per Day	Number of Days	Pounds of Clorine for Period
32 to 50	40	121	4,840
50 to 70	60	152	9,120
70 to 80	75	92	6,900
Total		365	20,860

The items in favor of chlorination are:

1. Gain in vacuum.
2. Elimination of rubber plug cleaning.
3. Elimination of boiling the condensers.
4. Elimination of the necessity of taking a condenser out of service to clean it, thus increasing the service availability of the unit.

The items against chlorination are:

1. Cost of chlorine.
2. Maintenance of chlorinating equipment.
3. Fixed charges on additional investment.
4. Hazard.

These items for and against chlorination were weighed for conditions at Kearny station and it seemed advantageous to install the system.

TURBINE-GENERATOR SETS

For Automatic Steam Substations

By R. G. Standerwick
Turbine Engineering Department
General Electric Company

A few years ago it was predicted that a time would come when it would be feasible to build automatic steam substations for the distribution of steam to be used by industrial plants, and to install in these substations turbine-generator sets that would be equipped with control devices for maintaining constant pressure at the exhaust and extraction outlets. This article describes such an installation

THERE has recently been completed two installations of the Rochester Gas & Electric Company, Rochester, N. Y., in which automatic turbine-generator sets have been installed together with the necessary protective features. One of these turbine generators, of 5,000-kw. capacity, is at Station 8; the other, of 3,000-kw. capacity, is at Station 9.

Each installation is composed of a group of boilers, fired by pulverized fuel, which supply steam at 320 lb. and 90 deg. superheat. The turbines are arranged with automatic pressure control devices, so that from the first stage shell the steam pressure is maintained at 150 lb. and at the exhaust 15 pounds.

These control devices are so interlocked that wide variations in demand at either the extraction or the exhaust can be handled independently without disturbing the pressure at either point. The performance of the control devices in maintaining constant pressures in the low-pressure steam lines is shown by the chart.

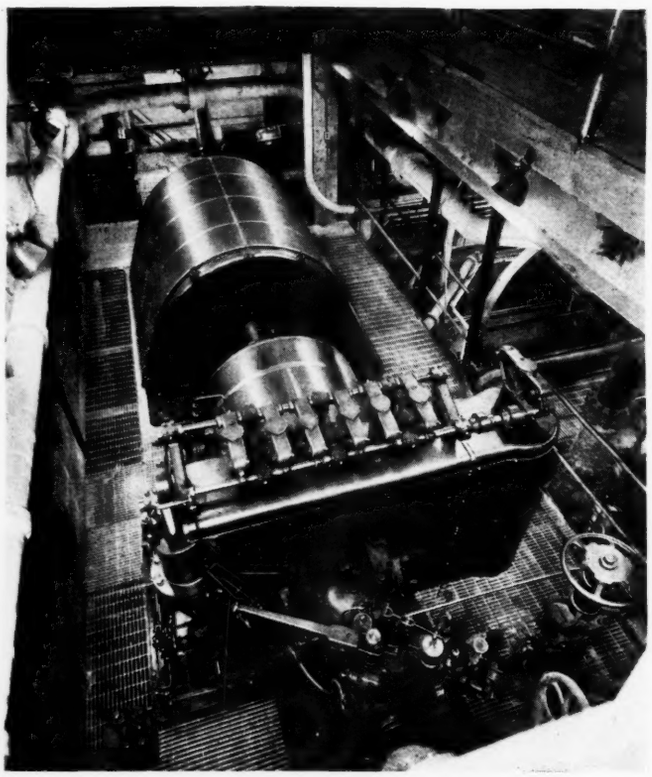
The generators are normally phased in with the main system of the Rochester Gas & Electric Company, and the output depends entirely upon the demand for extracted or exhaust steam. A variation in demand for high-pressure extracted steam is handled by the opening of the high-pressure valve gear only, while the variation in demand at the exhaust causes both the high-pressure and the intermediate grid valves to work in conjunction, so that the pressure at the extraction stage is undisturbed.

The motion of the high-pressure valves and the intermediate grid valve is accomplished by their respective power-operating cylinders. The pilot valves of these cylinders are moved by suitable oil relays, which are responsive in their position to the pressure governors at the extraction and exhaust outlets.

The turbines are equipped with standard centrifugal governors whose pilot valves rotate with the governors, the motion of the pilot valve being referred immediately to suitable oil relay pistons. The speed governors are used at the time when the generators are being synchronized with the main system, after which the pressure governors are put in control of the valve mechanisms. The centrifugal governors from then on are inoperative until conditions require a reversion to speed control.

It is an additional advantage to be able to utilize the maximum capacity of these generators in case of trouble with other generators on the system. To make this possible, automatic transfer devices have been installed on the turbines; so that, by the opening of a pilot switch, the turbines can instantly be transferred from steam pressure control to speed control independent of steam pressure. This is accomplished without causing a rise in speed of the turbines, because at the same instant that the transfer from pressure to speed control is made a resetting of the relative position of the speed governor with relation to the high-pressure valve gear is made. Thus the machine can be called upon to carry any load at 60 cycles in case it becomes necessary to operate the generator with an isolated load disconnected from the main system.

The transfer from pressure control to speed control is accomplished in either of two ways: Man-



The 5,000-kw. automatic turbine-generator set at Station 8

ually, at the request of the load dispatcher by the opening of a switch on the control board; or automatically, in terms of the frequency of the whole system.

Indication of the frequency is obtained from a device consisting of a synchronous motor driving a centrifugal governor; a pilot valve operated by the governor; an operating cylinder to which oil under pressure is admitted by the pilot valve; an oil reservoir; and an oil pump, also driven by the motor. Motion of the piston in the operating cylinder moves a series of contacts, which make and break circuits giving alarms and effecting the governing of the turbines. Setting of the contacts can be made with extreme accuracy with relation to the frequency of the system.

At 60 cycles three contacts are normally open and three normally closed. If the frequency drops to 59 cycles, one of the open contacts closes, operating an audible and visible alarm. At 58 cycles one of the normally closed contacts opens, and in so doing disrupts the current, which causes magnetic fulcrums on the valve gear to be tripped out, changing the machine from pressure control to speed control and throwing the high-pressure valve gear wide open under the control of the speed governor at a relative frequency of 58 cycles. In this way the generator develops its maximum output, and endeavors, by so doing, to prevent any further drop in the frequency of the main system. Assuming that even with its additional output the system is still overloaded, the frequency will continue to drop; at 56 cycles a second alarm will be sounded by the closing of one of the contacts of the frequency device; and at 55 cycles another contact will be made, which will trip oil switches acting as ties between the main system and the steam station.

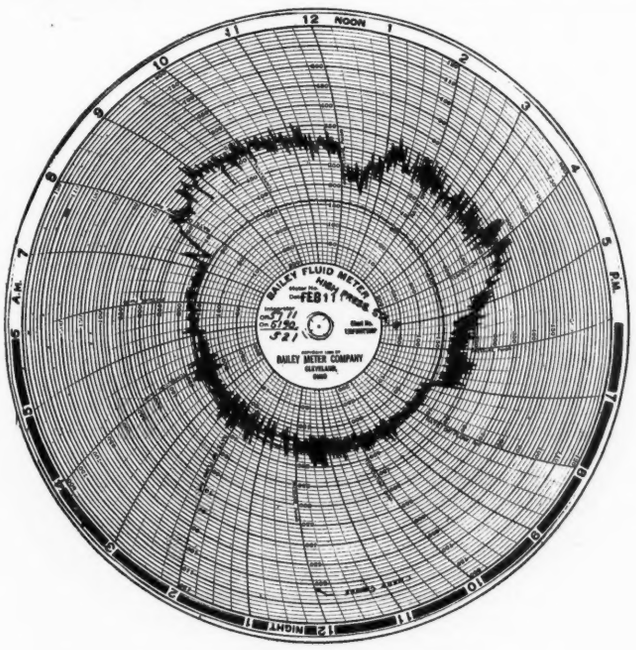
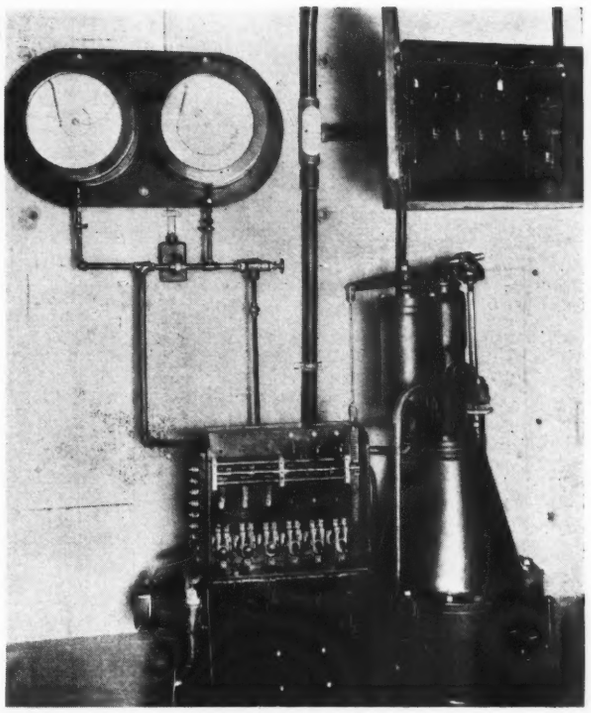


Chart showing the record of flow and pressure for the high-pressure extracted steam of the 3,000-kw. unit

There will, however, be a few circuits left on the steam station, which comprise the station auxiliaries and the electrical load in the immediate neighborhood, but the total electrical load left will be only that which can be taken care of by the maximum capacity of the turbine-generator set. As soon as the tie switches have been opened, the turbine-generator will bring the frequency of the isolated load back up to approximately 60 cycles and will stay at this value under the control of its own speed governor until the main system has been stabilized.



Contact making frequency device

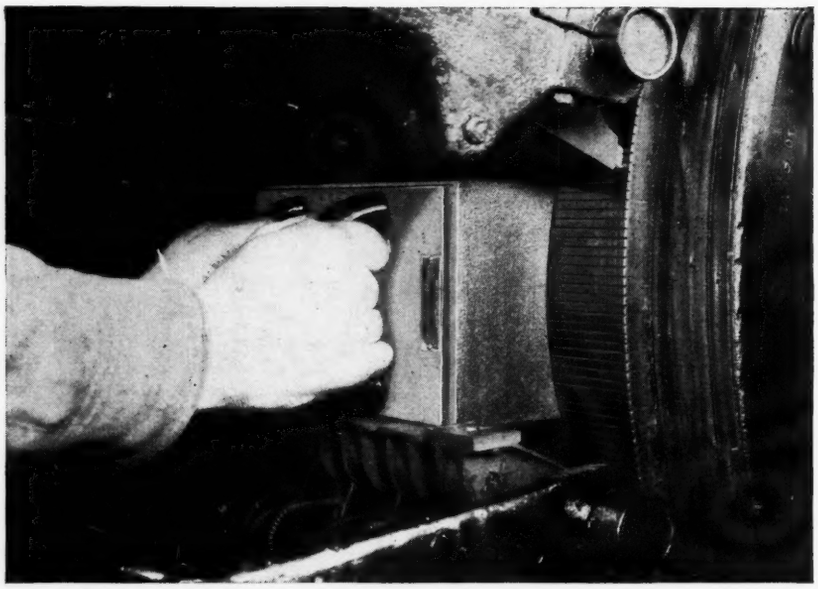
Within the conical casing at the right is the centrifugal governor driven through worm gearing by the synchronous motor. Above the governor is the oil relay with arm and rod connection to the rack and pinion for opening and closing the contactors in sequence.

By this protective means steam sub-stations may be relied upon to act automatically as stand-by stations, and even when operating at light loads may be called upon to immediately deliver their maximum capacity. While the pressure governors are normally set to maintain 150 lb. and 15 lb. pressure, respectively, they are equipped with motors so that the pressure setting can be remotely changed. This is often of great value, especially when dealing with steam supply lines of considerable length.

Pressure control devices can be installed at these distribution centers, and they, in turn, can modulate the pressures held at the station by means of suitable pilot lines connecting the pressure regulators with the pressure changing motors and in this way compensate for line drop.

In addition to these control devices the turbines are equipped with regular overspeed emergency tripping mechanisms that may be actuated either by the bolt-type emergency on the turbine or remotely by magnetic trip coils. In either case the tripping of the emergency not only closes the steam throttle, but also trips the generator main switch and the field switch. This tripping mechanism is also actuated by contact-making thermometers in the event of excessive oil temperatures. Four of these are installed, one to register temperature in the oil tank and the others on the main bearings.

In the frequency indicating device the speed of the oil pump and the oil pressure bear a definite relation to the speed of the centrifugal governor. Since the pressure of oil on the piston of the operating cylinder is balanced by a spring on the other side of the piston, every speed of the governor and oil pump is registered by a corresponding definite position of the operating piston. It is merely necessary to connect the piston by suitable mechanism to a pen to obtain a record of frequency.



A handstone provides a convenient way of removing defects from a commutator's surface

Searching Out Causes of Commutator Sparking

By Marin Phillips

Electrical Superintendent
International Paper and Power Company
Niagara Falls, N. Y.

SPARKING at the commutator on direct-current motors and generators indicates that something is not normal in the machine, either mechanical or electrical. In some cases the sparking will become so severe that the machine will have to be taken out of service for repairs, while in others it can be kept operating by giving frequent attention and renewing the brushes. Both conditions are expensive and should be avoided. In the first place, delays on production machinery are costly and are not tolerated in most plants. Secondly, increased maintenance costs and wear, with a consequent shortening of the machine's life, result.

Bad conditions on any machine—be it of the direct or the alternating-current type—can be brought about by improper attention, but the direct-current machine is more susceptible to neglect. Mechanical wear, and frequently the grade of brushes used, will continually keep the maintenance man worried.

It is to be expected that the commutator will be worn by the action of the brushes, and a certain amount of fine sparking is inherent in most machines. The brushes may wear grooves on the commutator surface that apparently do no harm, until the bearings' wear and the end play of the commutator increase. Then, trouble will be manifested, in the form of chipping off brush corners and side wear on the brushes, as well as lifting the latter from the commutator with each forward and backward movement. This trouble can be eliminated when the commutator is trued up by turning a small groove around the commutator neck near the risers. Then the brushholders can be staggered slightly so that the brushes will overlap the ends of the commutator bars when the end play is taken into consideration.

Direct-current machines often present some perplexing problems, the commutator being the worst offender—but it should not be too hastily condemned. Sometimes, from appearances and operation, one is led to believe that a certain commutator is beyond where it can be made to operate satisfactorily, whereas a little "doctoring" of the right kind will eliminate the trouble.

One of the most persistent cases of commutator sparking is high mica between the segments. High mica will bring about a multitude of commutator ailments, such as sparking of the brushes; heating; flat spots; blackening; excessive wear, caused by the burning effect and frequent turning or grinding of commutator; excessive wear of the brushes, due to the burning action and the rough commutator surface; noisy and chattering brushes.

Sometimes abrasive brushes can be used to keep the mica flush with the bars, providing the mica is not too hard and the copper too soft; while in other cases they will do little good. It should be kept in mind that when highly abrasive brushes are used on a commutator, they cause unnecessary heating and wear. If a commutator shows excessive wear while maintaining a shiny surface it is an indication that the brushes are too abrasive, while brushes with too little abrasive action on a flush commutator will cause black bars with high mica.

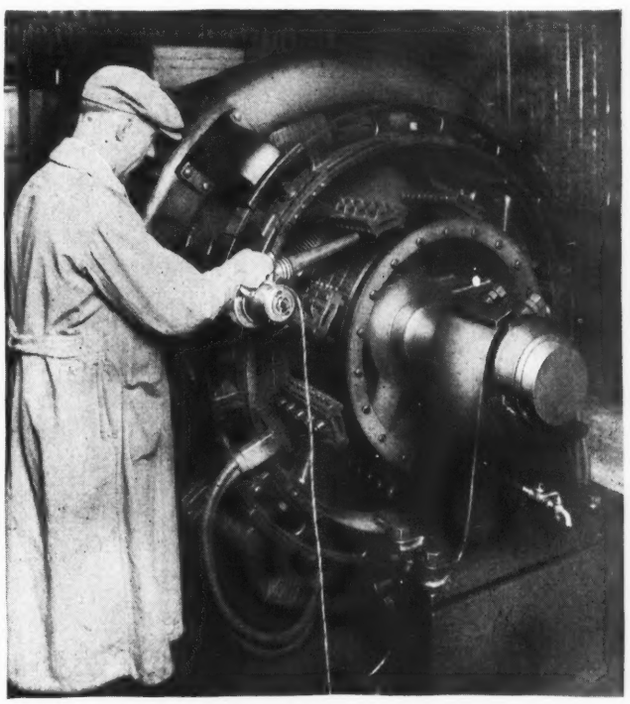
When there is sparking at the commutator due to high mica it will steadily get worse until the machine has to be taken out of service. Sparking eats away the copper and leaves the mica projecting above the bars. If a commutator is sparking badly and operating at a high temperature it is a pretty good sign of high mica. In such cases, grinding will work wonders for a short time, but frequently the old trouble will return. When grinding a flush commutator stops violent sparking, it is a fairly certain case of high mica.

There is no permanent cure for high mica except to undercut the mica below the surface of the commutator segments. The commutator should be trued up in a lathe, or turned or ground in place, the mica undercut to the desired depth and the proper grade of brushes installed. A tool should be used for undercutting that will remove all of the mica to the required depth of undercutting. If a commutator has been undercut before, considerable time can be saved if the old undercutting is gone over and deepened before turning or grinding. When this is done, it is only necessary to clean out the copper burrs from between the segments after turning. The ideal commutator is one that has been undercut and provided with brushes that maintain a clean chocolate-brown surface.

There was a time when any old piece of carbon or graphite was considered good enough for the brushes of direct-current machines. That time has passed, and the application of brushes has developed into a science. When in doubt about the proper brushes to use on a given machine it is advisable to consult the engineers of the brush manufacturers. Brushes should be selected with great care, and there is no better way to do this than to call on the brush manufacturer for advice, who will render it gratis.

Left — Grooves in the commutator combined with end motion of the armature will cause side wear on the brushes

Right—An electrically driven hand blower is a labor saver when inspecting and cleaning power equipment



It should not be assumed that proper brushes will cure all sparking evils. Correct brushes to work satisfactorily must be well fitted to the commutator surface and they must not stick in the holder because of dirt or of being too thick. The brushes must be equally spaced around the commutator. They must set at the proper angle if quiet operation is to be obtained. The brush-holder studs must be parallel with the commutator bars. The brushes must work freely enough in the holders so that they will snap back against the commutator when raised slightly and released.

The proper spring tension on the brushes is of vital importance. If the tension is too low it will cause sparking and commutator heating. On the other hand, if the tension is too great, it will cause rapid wear and heating of the commutator and brushes. A spring tension should be maintained that will insure the brushes making good contact with the commutator.

Proper fit between the commutator and brush is important. This is generally obtained by passing sand paper back and forth under the brushes. When a new set of brushes is to be put on a machine whose commutator is being ground they should be put in the holders and the machine run long enough to grind them in before the finishing stone is applied to the commutator. This procedure will insure a good brush fit and save a tedious job of sand papering. Brushes with the same degree of bevel should be used; then when the brush-holders are once set to the proper angle brush-fitting will be a minor job.

Many direct-current motors and generators are equipped with commutating poles. This type of machine is sensitive to brush setting in relation to the field poles. If the brushes are not set at the exact neutral, sparking of a more or less serious nature will result, depending on the load carried and how far off neutral the brushes happen to be.

The proper location for the brushes is best found by trial, that is, shifting the brush-holder yoke slightly in one direction and then the other until the minimum sparking exists at no load and at full load. The proper place for the brushes is usually marked. This should give the best operating results, provided no changes have been made on the machine. It should be remembered that the shifting of the brushes on a direct-current motor will change the speed, which in most cases is undesirable except to get proper operation. When trying to eliminate sparking at the brushes it should not be overlooked that the machine may be overloaded, which is sometimes the cause of sparking at the commutator, heating and other troubles.

New Boilers and Increased Pressure To Reduce Power Costs

By replacing seven twenty-year-old boilers, now operating at 150 lb. pressure, with three new water tube boilers to operate at 385-lb. pressure, and reblading a 3,500-kw. turbine unit for this pressure, the Washburn Wire Co. expects to greatly reduce the cost of operating its power plant.

OPERATING in parallel with the Narragansett Electric Light and Power Company system, the Washburn Wire Company's power plant supplies power and steam for process and building heating for both its own mill and the American Electrical Works. The mills are at Philipsdale, Conn., on the Seekonk River. The wire company manufactures steel rods and wire, and the American Electrical Works manufactures bare and insulated copper wire and cables.

Originally, the boilers supplied steam to engines for driving the various rolling mills. About seven years ago, in an effort to speed up production, an electrification program was inaugurated, and 6,500 hp. of steam engine drive was replaced by electric motors.

Four years ago a 3,500-kw. turbine-generator was installed to furnish a part of the power requirements. The turbine exhausts to a low-head jet condenser and is arranged for bleeding steam at 10 lb. pressure from between the impulse and reaction blading.

The old boilers had reached such a condition that the insurance inspectors threatened to reduce the allowable operating pressure, thus making the installation of new boilers inevitable. It was decided not to alter the present boiler house, but to install the new boilers in the same location as the old ones. This meant that the installation work had to be carried out piecemeal in order not to interrupt power and steam service to the factories.

The first step involved the removal of two of the old boilers. One of these permitted the first new boiler to be installed, and the other made room for new boiler auxiliaries.

The boilers are of the four drum Stirling type, and contain 4,290 sq.ft. of heating surface. Steam is generated at 385 lb. pressure and superheated to a total temperature of 675 deg. The superheater is located in the first pass, and is of the multiple-bend type, arranged so that the headers are outside of the boiler above the steam drums.

The furnaces and settings have been designed for oil firing with provision for pulverized fuel. Three mechanical atomizing burners for each boiler permit ratings of about 200 per cent. The side walls and front are of solid firebrick, but the bridge wall and furnace bottom are hollow. The bottom of the furnace consists of two layers of firebrick, 2 in. of ground firebrick and 7½ in. flue tile. Air for combustion is preheated in passing through the hollow bottom and bridge wall. The front arch is of the suspended type.

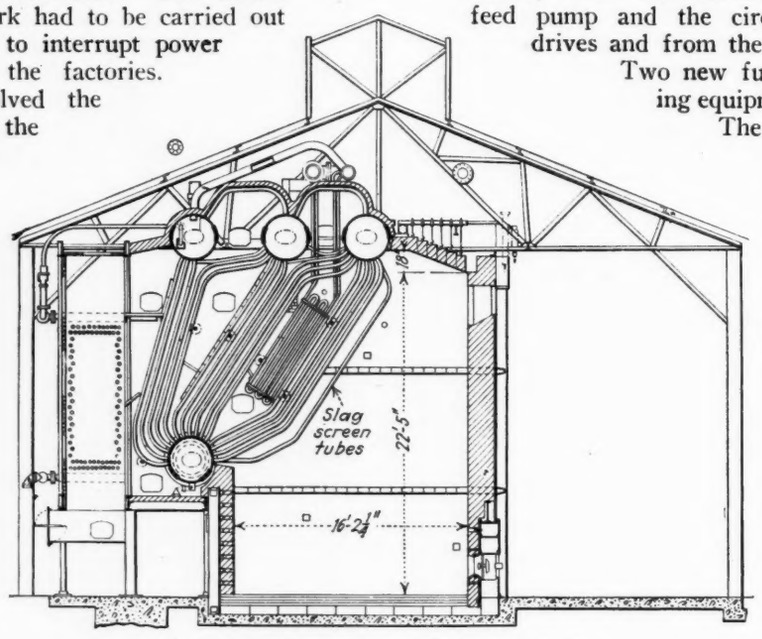
The first boiler installed is equipped with a 1,506-sq.ft. integral steel-tube economizer capable of heating the feed water from 215 deg. to 298 deg. at 200 per cent rating. Economizers are not being installed for the other two boilers, as only by operating the first boiler under base load conditions was the economizer installation justified.

It will be seen from the cross-section that the new boiler is a close fit in the old boiler house. This has necessitated running the uptake flues outside and along the back of the boiler house. A 43,000 c.f.m. induced-draft fan has been installed to provide the additional draft required by the economizer. The fan is arranged so that it can be bypassed, and natural draft is supplied by the present 175-ft. high, 7 ft. 6 in. diameter brick stack.

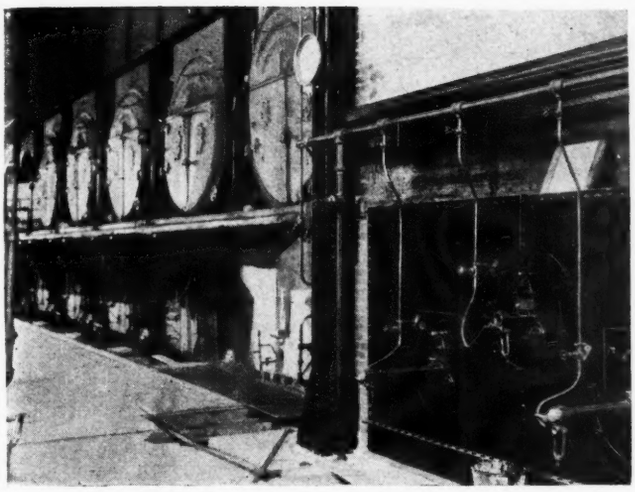
Two 150-g.p.m. pumps, one steam driven and one motor driven, have been installed to feed the new boilers. Because of the poor circulating water and the jet-type of condenser, feed water is 100 per cent make-up. Hot water that has been utilized to cool the rolling mills as used for feed water after being treated with disodium phosphate and further heated in an open deaerating heater, which receives exhaust steam from the feed pump and the circulating pump turbine drives and from the fuel oil pumps.

Two new fuel oil pumps and heating equipment have been installed. The oil is heated to a temperature of 200 deg. and fed to the burners at 300 lb. pressure.

Each boiler is equipped with a boiler meter for recording steam flow, air flow, draft and flue-gas temperatures, in addition to pressure gages and a fuel oil meter. It is expected that the new boilers and economizer will operate with close to 80 per cent efficiency, whereas the old boilers were operating at about 60 per cent efficiency.



Cross-section of new 4,290-sq.ft. boiler



Boiler room at the Washburn Wire Company's plant, showing both new and old boilers

To place the turbine in condition to utilize the 385-lb. steam pressure new nozzles and two new rows of blades will have to be installed. It is expected that this work can be accomplished over a week-end, so that purchasing a large amount of power will not be necessary. The turbine manufacturer guarantees the rebladed turbine to deliver 3,100 kw. and 12,000 lb. of steam to process on 48,000 lb. of steam supplied to the throttle. The turbine previously required 62,000 lb. of steam to produce the same kilowatt load when bleeding the same quantity of steam.

The turbine is operated in parallel with the central station power, and at such a load as will supply all of the 10-lb. bled steam needed for process and building heating. Thus the turbine carries a fairly constant load and the purchased power supplies the peaks. The total plant load is extremely variable; the utility being called upon at times to furnish peak loads of 1,500 kilowatts.

During the summer the low-pressure bled steam required amounts to about 10,000 lb. per hour. In winter this load is increased by building-heating requirements to about 20,000 lb. an hour. In addition to the low-pressure steam, about 15,000 lb. per hour of steam at 150 lb. pressure is required by various pumps and other uses in the mills. The steam is supplied from the high-pressure main through a desuperheater and reducing valve.

All of the new steam and water piping in the boiler room and the lead to the turbine, made necessary by the higher pressure, is of welded construction and insulated with 85 per cent magnesia.

Germany Investigates per Capita Use of Power

A NOTABLE investigation to determine the horsepower per employee used in Germany, the United States and the United Kingdom, in which all plants employing more than 50 men were included, was recently carried out by the German Business Research Institute. As a result, it has been found that Germany is leading in the iron, steel, and coal-mining industries.

In blast furnaces and steelworks the per capita use in 1928 was 18.7 hp. in Germany, 17.5 hp. in the United States, and 11.1 hp. in the United Kingdom. In coal-mining, the per capita horsepower was 7.7 in Germany, 5.4 in the United Kingdom, and 4.9 in the United States. In shipbuilding, however, the percentage ratings were 6.2 in the United States, 3.9 in Britain, and 3.4 in Germany; and in the automobile industry 2.8 hp. in the United States, 1.4 in Germany, and 1.3 in the United Kingdom.

The ENGINEER

By HIRAM PERCY MAXIM

You are an engineer only if you can be absolutely truthful with yourself. You deal in facts. Facts are truths. The truth—the unvarnished truth—is what you build upon. And you build the greatest of men's works.

The truth is the only thing in this world that is one hundred per cent dependable. Therefore is the engineer confident if he has been truthful with himself.

Truth is merciless. It plays no favorites. It is not swayed by oratory, appearances or sentiment. And thus it takes courage to face it. The engineer must have courage, for he must face truth without flinching. **And so to be an** engineer one must be courageous, confident, brave and fearless.

The truth is not always easy to find. When it cannot be found, judgment must be called in. The engineer's judgment must be unbiased, unprejudiced, unashamed of its ignorance and unswerving in its faith in the logical, the reasonable and the orderly.

The guess, the hunch and the **gamble have no** place in engineering.

All men may not be **engineers.**

Texas-Louisiana Co. Rebuilds

DIESEL POWER PLANT

Without Interruption to Service

By R. E. HUTCHSTEINER

The Texas-Louisiana Power Company, when taking over the light and power business in Silver City, N. M., found itself in possession of an antiquated power plant, which it proceeded to modernize without interruption to service. The program embraced the erection of a new steel-and-brick building that completely inclosed the old plant, and the replacement of the old machinery by new Diesel engines

THE old power plant supplying electrical power to Silver City, N. M., was a stone structure located on a hillside, in the center of the town. The Diesel engines were of the horizontal air-injection type of an early design. As Fig. 2 shows, the drive was by jack shafts and belts, making the plant difficult to operate efficiently.

The new building, erected by the Texas-Louisiana Power Company to replace the old plant, was designed for both convenience and attractiveness. The hillside location made it desirable to plan the new engine room floor below the street level, so that the passer-by might look directly into the building.

The interior of the plant is shown in Fig. 4, the equipment consisting of two 600-hp. De LaVergne, four-stroke-cycle mechanical-injection Diesel engines (in the center foreground), and two 1,125-hp. solid injection Diesel engines (one of which is shown in the background).

In front of the 1,125-hp. unit, may be seen the foundation for a second 1,125-hp. engine, which was not installed when the photographs were taken. The present capacity of the station is 3,450 horsepower.

Although the station is subjected to severe "jolts," caused by hoisting and air-compressor loads in the mines, to which this station supplies power, the engines operate together satisfactorily, sharing and dividing the load evenly.

The piping has been installed in a remarkably satisfactory manner. For example, the large diameter air-intake pipes supplying each engine are carried below the floor level, as shown at the right-hand end of the engines in Fig. 4. The intakes are all connected to a common large-diameter air-supply duct, below the engine-room floor, which is carried outside the building. This not only simplifies the piping, but also eliminates from the engine room the noise and pulsations of the air intake.

The end of the air-supply tunnel is fitted with filters, so that the engines are supplied with clean air, an important item in the Southwest, where sand storms are the rule rather than the exception.

The exhaust manifolds on the engines are water-cooled, the exhaust being conducted away from each engine in long-radius-bend piping to the mufflers, located outside on the roof of the building. It is interesting to note that, although a hotel is next door to the power plant, the mufflers so effectively silence the exhaust that no complaints of any kind have been experienced.

All water, fuel oil, and lubricating oil piping is carried below the floor level in roomy pipe trenches, as are also the lubricating oil coolers and fuel oil filters.

The switchboard is shown in Fig. 5. The blank space on the left was left for the panel of the 1,125-hp. unit, which has since been installed. The oil switches are mounted against the wall, away from the panels, and are operated by bell cranks and rods, making a safe, clean, and attractive layout.

The lubricating oil storage tanks, fuel oil supply tanks, and the lubricating oil reclaimer, are located on a gallery above the switchboard, the stairs leading to this gallery being clearly shown in Fig. 5.

All lubricating oil, after being used in the engines, is returned by a pump driven directly off of the end of the engine crankshaft to individual, closed pressure tanks on the gallery. From these tanks, the lubricating oil flows by gravity (assisted by the pressure head) through the coolers, and thence directly into the force-feed lubricating systems on the engines.

In this way the lubricating oil is supplied to the engines at the lowest possible temperature, immediately after having been cooled, and the lubricating oil in the overhead storage tanks is somewhat warmer and more easily purified and cleaned. The lubricating oil is purified in a chemical reclaimer, the oil being withdrawn from the engines for cleaning, and returned to the engine without the necessity of any pumping.

The main fuel oil storage tanks are outside the power house. A small supply of fuel oil is kept in tanks on the overhead balcony, from which point the oil flows

Fig. 1 (Left)—The scene five years ago when the plant was down at the heel

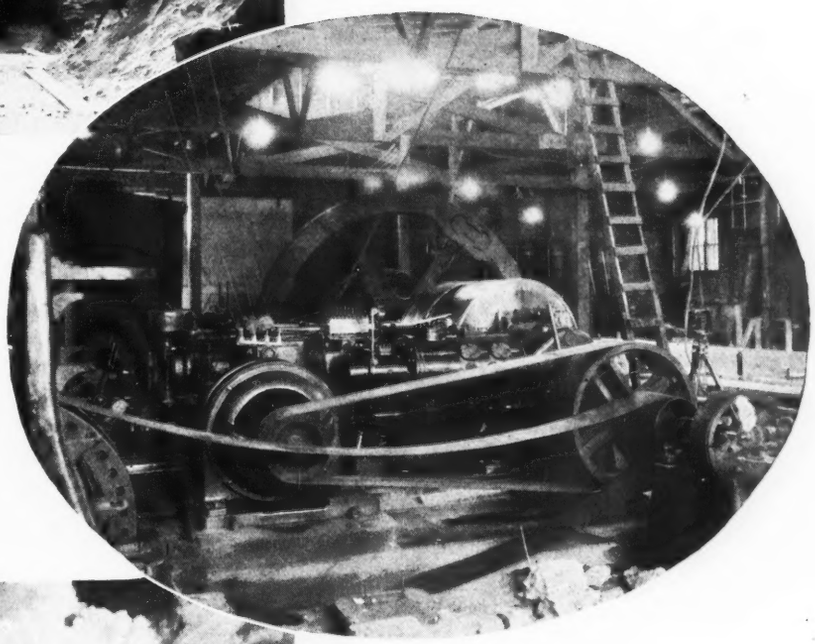


Fig. 2 (Right)—The interior of the plant would have taken the heart out of most engineers. That the plant ran at all proves the operator's strength of character

Fig. 3 (Left)—The new power plant, of which the town boasts to the visitor

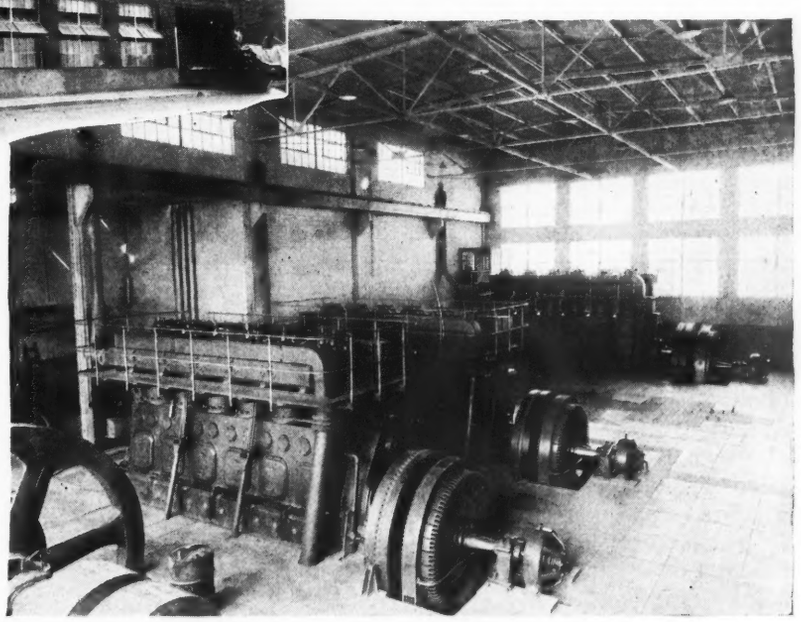


Fig. 4 (Right)—The De La Vergne Diesels that now supply the power

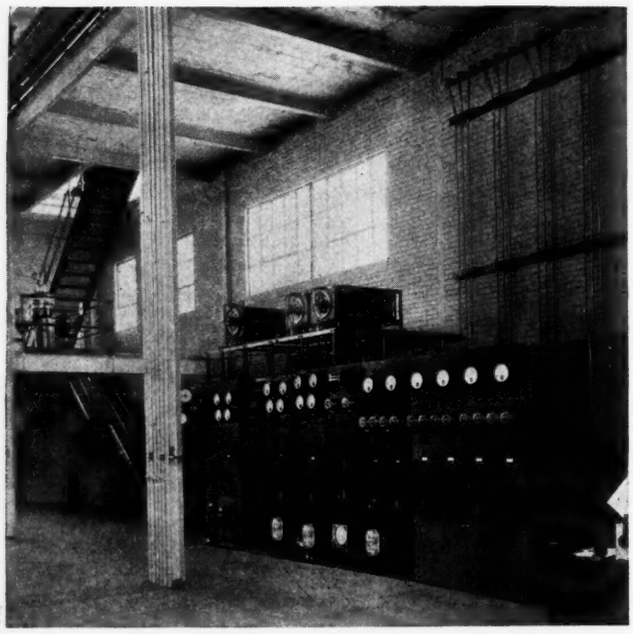


Fig. 5—The switchboard is in view of the engine operator

by gravity to float controlled stand-pipe boxes on each engine.

The water-cooling towers are on the roof; one tower is used for the Diesel engine system, and the other for the cooling water for the ammonia condensers in the adjoining ice plant.

The engines are of the vertical-box-frame type, with the frame sitting upon a substantial base which also carries the crankshaft bearings. The cylinders are separate castings bolted to the frame and are provided with removable liners. The 600-hp. units have six cylinders 17 in. diameter x 24 in. stroke, with a r.p.m. of 225. The 1,125-hp. units also have six cylinders each, but these are 22 in. diameter x 30 in. stroke. In spite of this diameter, cooling of the pistons is not required.

IN THE PRESENT STATE of oil treating and handling, few companies purchase their insulating oils on detailed specifications. Rather it seems to be the common practice for the operating companies to use the oils suggested or recommended by the equipment manufacturers for transformers and oil circuit breakers. However, there is a growing tendency by operating companies toward the use of their own detailed purchase specifications covering insulating oils. The majority of companies still purchase their insulating oils from the equipment manufacturers. A number of companies on the Pacific Coast buy directly from oil refiners, as do several of the largest utility companies of the country. Most companies report finding water, sediment and metallics in new oil shipments. The number of companies frequently finding water in their new oil is about twice the number finding sediment or dirt and about three times the number finding metallics. Because of these conditions, quite a few concerns make a practice of passing new oil through a centrifuge or filter press before transferring it to storage tanks. After storage, on the majority of systems, the oil is similarly treated prior to being used, when it does not meet the required dielectric tests.—*N.E.L.A. Electrical Apparatus Committee Report.*

Starting a Carbonic Acid Compressor

BY JOHN L. ANDERSON

THE best way to start a CO_2 compressor is to turn on the condenser water flow first. Then open the discharge stop valve and bypass valves. Slack the soft packing and open the suction stop valve about $\frac{1}{8}$ turn. Then start the compressor and close the bypass valves. If the discharge pipe feels cool, leave the suction valve the way it is. When the discharge warms up, open the suction valve a bit. If the discharge cools off again, wait a while before opening the suction valve wide.

By following this procedure, there will be no danger of shots of liquid causing the machine to pound and possibly to wreck it.

The suction stop valve should never be entirely closed when starting the compressor, because all the oil will be drawn from the lantern in the stuffing box. The oil pump may take an hour or more to fill this space again, and in that time the packing may be ruined. The stuffing box does, indeed, require special attention, but it is of a different nature than that of the ammonia machine.

If the rod of an ammonia compressor starts to heat, the engineer usually slacks off on the gland until a slight odor of ammonia becomes evident. This allows the rod to cool off, and the leakage soon stops. If the leather or metallic packing on a CO_2 compressor is slacked off while the machine is running, a great leaking of gas will take place, and, owing to the high pressure, will soon cut the packing. The soft packing on the rod is the only packing that should be handled—slacked off when starting and tightened when the machine is stopped. Very little trouble is experienced in a CO_2 system from air being trapped, owing to the small space occupied by the air at high pressure, and to the fact that air enters the system only when the cylinder is opened or piping repaired.

If the amount of liquid in the system is allowed to get so small that the expansion valve does not frost over, there must be an enormous leakage, or else the machine has been operating with a low charge for days.

The best method of telling how much liquid is in the system from day to day is by watching how much frost forms on the machine under similar temperature conditions. Both suction-valve covers should be coated with frost after an hour or so of running, under the same conditions. Overcharge is indicated by a cool discharge line.

There are many kinks in a CO_2 plant that are to be learned by experience. The engineer operating a CO_2 system for the first time, would do well to keep his eyes open and not rely entirely on knowledge gained in an ammonia plant.

A COMPETITOR OF VOLCANIC STEAM—Patents to cover a process for burning coal underground and piping the resultant gas to the surface have been applied for. The inventor claims that by controlling the burning coal, either petroleum or carbon dioxide may be produced. From the former, he said, can be refined gasoline, while from the latter dry ice can be manufactured—both at low cost. It was further explained that the gas can be piped to the consuming area or burned at the mouth of the mine and transformed into electricity. While he did not reveal the workings of his process specifically, he said the first production work would start either in Illinois or Pennsylvania.

Right Out of the Plant

A Simple Way to Correct Polarity of Generators

IN 1907 I was operating the power station at Springfield, Mo. There were four 550-volt compound direct-current generators in this station. One generator, which supplied power for the street railway, was a direct connected type, and another, which supplied power to the motors around town, was belted to the same engine. The other two generators were parts of motor-generator sets. During the day, the two motor-generator sets were run from an alternator. In the evening, the engine-driven direct-current unit was started and the motor-generator sets stopped. This made two changeovers each 24 hr. The generators were connected to the equalizer and line busbars by means of single-pole double-throw switches, so that any machine could be connected to either the power or to the railway busbars, as shown in the figure.

One morning the direct-current ammeters were indicating in the wrong direction. During the changeover, the night engineer had made a mistake, and the result was

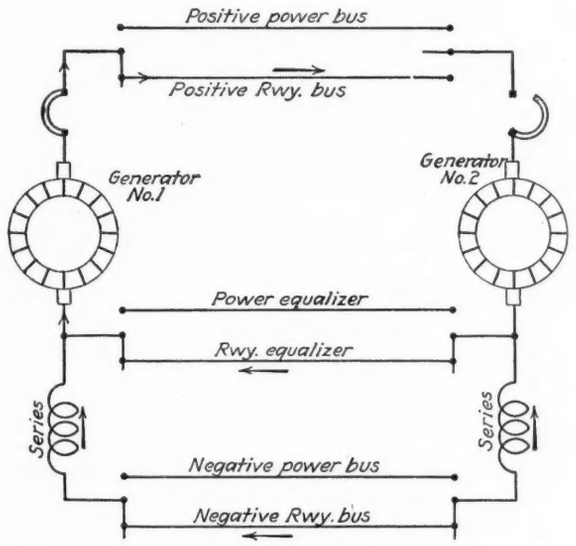


Diagram of how the generators were connected to correct the polarity of No. 2 unit

that the polarity of the generators on both motor-generator sets was reversed. When paralleling, we always closed the equalizer and the negative line switches of the incoming machine first, then built up its voltage. I had often noticed that when these switches were closed the machine that was carrying the load lost some of its voltage. I drew a sketch to see why this happened, and found that part of the line current was flowing through the series winding of the incoming machine, then through the equalizer to the armature of the machine that was carrying the load. This condition suggested a possible way of correcting the polarity of the reversed generators.

I started up the direct-current engine-driven unit and found that the belted generator was reversed, but the direct-connected railway generator had correct polarity, so I tripped the direct-current breakers of the motor-generator sets, opened their shunt fields and put the direct-connected railway generator on the railway busbars. Next I threw the equalizer and negative switches of the power motor-generator set down on the railway busbars for a few seconds. The bypassed current reversed the residual magnetism and it was ready to be put back on the power busbars. To correct the polarity of the generator on the railway motor-generator set, I closed the equalizer and line switches as usual, and the bypassed current reversed the residual. When this was done all that was necessary was to finish paralleling and take the direct-connected generator off the line.

I did not bother about the belted generator, because its polarity would be corrected automatically in the evening during the operation of paralleling. Thus the polarity of all three generators was corrected merely by operating switches.

FRANK ROYCE.

Wilkinsburgh, Pa.

Why Delay Power Plant Improvements?

IN THE Nov. 12 number of *Power* there was an editorial "Why Delay Power Plant Improvements?" and in that editorial a case was cited in which improvement was not made until it was forced by reason of probable interruption to operation. There is a reason which is used very often and which is hard to combat and that is the ease with which power may be obtained from public utilities with a minimum of investment, in the first instance, and the fact that increasing needs can be met more or less automatically without further investment or alterations to existing equipment.

In fact, when a mill power plant deteriorates to a point where major repairs or replacements are necessary, manufacturers will abandon the old equipment and make contracts for power, retaining only that equipment necessary for heating. Various reasons are given for doing this, one being that money is not available for rebuilding; another that available money had best be invested in replacing manufacturing machinery or extending the business; and still another that the cost of power is such a small part of the total cost of the finished product that a saving of even 25 per cent is inconsequential.

Several manufacturers have told me that they consider the convenience of being able to increase their use of power, with no effort, financial or otherwise, on their part, was of more importance than any prophesied saving in making it; that there was no inducement sufficient to offset the nuisance or responsibility of operating a power plant.

While this may be true at times, there are numerous cases where power is purchased and at the same time boiler plants operated and fuel used to an extent that would provide both heat and power. I have known many instances where the net return would be 20 per cent or more on the necessary investment and where the manufacturer could assure himself of that fact by consulting a competitor. Yet he could not see sufficient advantage to warrant tying up capital in power equipment.

There are probably few instances of a manufacturer setting aside each year a sum sufficient to rebuild or

replace worn-out equipment, and a proposal to rebuild is a proposal to invest new capital. When process machinery wears out or becomes obsolete the manufacturer is forced to make replacements, because no one will furnish him the machinery for a fixed annual charge. When his power plant gives out the public utilities will provide the equivalent of the machinery for an annual charge with no more effort on the part of the manufacturer than signing a contract. I am not arguing as to whether this is right or wrong, I am simply stating it as a fact.

From the manufacturer's standpoint, it is undoubtedly a great advantage to be able to buy certain raw materials and be relieved of the burden of investment and operation that would be required to produce them. When the difference in cost means nothing in the selling price of the finished product, and very little in its actual cost, it becomes difficult to convince.

Thinking in terms of per cent rather than indefinite sums has helped the public utilities, and competition has apparently not yet reached the point where every dollar must be saved whether it is 1 per cent or one-tenth of 1 per cent.

WARREN B. LEWIS.

Providence, R. I.

"Causticity Plus" in a Boiler Water

IN THE Oct. 22 number of *Power* there was an excellent and timely editorial entitled, "Boiler Compounds and Patent Medicines," to which I heartily subscribe. During the past summer I had occasion to examine conditions in a small plant, and those conditions are so pertinent to the recommendations of the editorial, that they are herein briefly summarized.

Three 1,500-sq.ft. boilers, of the horizontal return-tubular type, and with operating pressure of 90 to 100 lb., are fed with well water, softened by the zeolite process. The treated make-up in summer is approximately 100 per cent; in winter, 50 per cent. The temperature of the feed water is raised to 200-210 deg. in an open-type heater. There is no difficulty from scale formation; but corrosion of steam lines and, at times, foaming have caused trouble.

Analyses of feed and boiler water are as follows:

	Parts per million		
	Untreated Water	Boiler No. 1	Boiler No. 2
Hydroxide (OH)	0	592	642
Carbonate (CO_3)	0	842	1068
Bicarbonate (HCO_3)	447	0	0
Sulphate (SO_4)	32	418	451
Chloride (Cl)	9	209	202
Silica (SiO_2)	17	....	....
Calcium (Ca)	85	....	....
Magnesium (Mg)	30	....	....
Sodium (Na) Calc.	47	....	....
Temporary Hardness as $CaCO_3$	337.5	....	....
Permanent Hardness as $CaCO_3$	0	....	....
Total alkalinity as sodium carbonate	....	3334	3880
Total sulphate as sodium sulphate	....	618	667

The hardness of the untreated water is all in the temporary form. In addition, present therein is 49 parts per million of sodium bicarbonate. Treatment by the zeolite process results in the feed water containing a large quantity of sodium bicarbonate, which in passage through the heater and in the boiler is converted first into sodium carbonate and, finally, partially to caustic soda. Consequently, the boiler water contains a tremendous concentration of caustic and carbonate alkalinity. The effect of the boiler water on the skin when tested with one's hand was definitely indicative of this high alkalinity, and the analyses confirm the conclusions, as a total alkalinity of 3,334 and 3,880 parts per million expressed as sodium carbonate was found in the two samples analyzed.

The development of alkalinities such as these in the boiler water is extremely undesirable for a number of reasons. Most important is the danger of damage to the boiler metal. Thus, although the ratio of sodium sulphate to total alkalinity in the boiler water should be 2.0, according to best recommendations available (*Mechanical Engineering*, May, 1929, page 388), that actually existent in these boiler waters is 0.185 and 0.172, respectively.

While opinions may differ as to whether caustic alkalinity is primarily causative or only contributary to boiler rupture, it is the part of good judgment to establish in the boiler water only the slight concentration of alkalinity that is essential for best protection of the boiler metal, and to limit it thereto. With that done, it becomes a simple matter to maintain the ratio of sodium sulphate to total alkalinity as recommended. In this way the operator avoids also the increased tendencies to foaming inherent in a highly alkaline water. Limitation of the necessary concentration of sodium sulphate likewise results in the possibility of smaller concentrations of dissolved solids in the boiler water. Thus, in the present case, if the softening were by lime alone, the feed water would contain less than one-third the total dissolved solids now present, and would develop in the boiler less than one-tenth the alkalinity now present, making the ratio of sodium sulphate to total alkalinity 1.5 without further treatment.

It has been mentioned that some trouble existed in the form of corrosion of steam lines. This is traceable to the combined effect of the oxygen left in the effluent water of the poorly vented heater, and to the large quantities of carbon dioxide injected into the steam by the decomposition of the bicarbonates in the feed water.

One would scarcely conceive of adding alkaline chemical to the already highly caustic boiler water as a remedy for this condition of the steam lines. Nevertheless, it was found that an enterprising boiler-compound salesman had sold several barrels of his special brand to combat this trouble. Analysis of the compound follows:

Sodium silicate	39.2 per cent
Caustic soda	3.1 per cent
Organic matter	Present in small amount
Water	Approximately 56-57 per cent

One resents somewhat seeing a compound of this nature sold for more than 20c. a pound, when ordinary waterglass, which contains 40 per cent of sodium silicate, sells for a couple of cents or less a pound. That, however, is a matter that concerns only the owner of the plant and the salesman, so long as the element of danger to human life does not enter.

In the case cited, however, the salesman sold a strongly alkaline product and gave recommendations for its addition to a boiler water already dangerously high in caustic. Probably he was ignorant of the existing conditions, and ignorant also of the dangers engendered from maintenance of excessive caustic concentrations in the water.

Should such ignorance be permitted in recommending compounds for boiler waters? It is definitely recognized today that certain conditions in the boiler water are dynamite with a time-fuse of uncertain length. Does it not therefore follow that the element of human safety demands that those professing skill in the art of processing water for such purposes and seeking emolument therefrom, whether by sale of material or service, should be adjudged by proper authorities competent to accept such responsibility before being permitted to seek it?

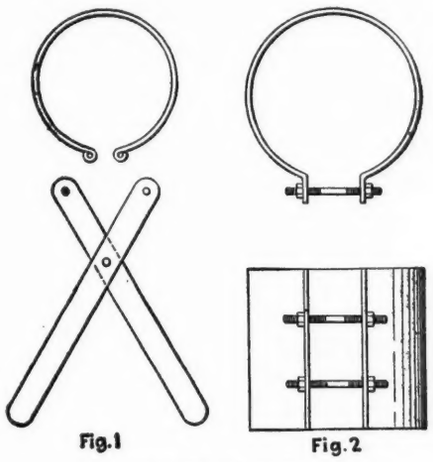
Pittsburgh, Pa.

R. E. HALL,
Hall Laboratories, Inc.

Tools for Compressing Piston Rings of Diesel Engines

WHEN overhauling Diesel engines there is usually difficulty in compressing the piston rings when replacing the piston in its liner. The tool shown in Fig. 1 for doing this work consists of a circular ring guard made of sheet steel, slightly wider than the piston ring, and having small holes, or loops, at the ends. Another tool is then made consisting of two arms pivoted, as shown, and fitted with pins at one end. In operation, the guard is fitted round the piston ring, the pins of the tool engaged in the holes and the ring is compressed by applying pressure to the other end of the arms. This will compress the piston ring so that it can be slipped down into the liner.

Fig. 2 shows another useful tool. It consists of a circular guard of sheet metal made the same size as the



Details of tools

piston and tightened by the bolts. When the bolts are tightened the guard will fit snugly around the piston and hold the rings compressed in their grooves. It should be of sufficient length to cover all the rings on the piston. It is fitted with four feet to stand on the cylinder top. When a piston is being replaced in the liner it should be lowered until the bottom groove rings are ready to enter the liner. The guard should then be placed around the piston and allowed to rest on the cylinder top above the liner. The two bolts should then be tightened gradually and evenly so that the rings are compressed in their grooves. The inside of the guard should be kept well lubricated during use.

W. E. WARNER.

Brentford, England.

Relative Economy of Pulverized Coal, Oil and Gas As Boiler Plant Fuels

WITH reference to the article on "Relative Economy of Pulverized Coal, Oil and Gas As Boiler Plant Fuels," by Martin Frisch, which appeared in the Nov. 5 number of *Power,* there are certain figures given and conclusions drawn with reference to fuel oil that are subject to correction.

In the table giving the ultimate analysis, the values for oil do not agree with those obtained from what is known as "Bunker C" oil, this being the oil most commonly used by shipping interests and by power plants along the Atlantic seaboard, its gravity being 14 to 16 deg. Baumé. The general run of "Bunker C" fuel oil has a sulphur content of approximately 1.7 per cent. In over 40 barge shipments of 7,000 bbl. each, the sulphur varied from 1.5 per cent to 2.2 per cent, the average of all samples being 1.7 per cent. The hydrogen content of "Bunker C" oil averages about 10.50 per cent, this value also being the result obtained from barge shipments over a period of two years. The heat content from the same samples averages 18,680 B.t.u. per lb., the weight 8.093 lb. per gallon. The moisture content given also appears high, as "Bunker C" oil rarely shows more than a trace.

The hydrogen, sulphur, oxygen and nitrogen, and pounds of air required per pound of fuel given by the author check more nearly the values obtained from 26 to 28 deg. Baumé oil, whereas the carbon and B.t.u. values checked equally well with the values usually found in 14 to 16 deg. Baumé oil. It would be of interest to know the grade of oil referred to by Mr. Frisch and from what "field" it was obtained.

In Fig. 1, item 10, for oil, appears excessive. The chart indicates a cost of $450,000 for fuel-oil-handling equipment, the same as for Pocahontas coal and within 10 per cent of the cost of equipment for Pittsburgh coal. To compare oil as a fuel with bituminous coal, a high-grade stoker installation with modern unloading towers, conveyors, storage reclaiming apparatus, weighing devices, ash-disposal equipment, etc., is necessary, or an expensive powdered-coal installation, either of which will cost about double the necessary oil storage and burning equipment.

In burning the different fuels, the moisture, hydrogen and sulphur content are quite important, and, of course, the ash, which is absent in oil. Oil can be burned with less excess air than any other fuel, not even excepting powdered coal, principally due to its ease of atomization, resulting in almost perfect mixing with the combustion air. The complete atomization and perfect mixing possible with oil eliminates the stratification so common to stokers and, in some cases, to pulverized coal installations.

Item 6 in Table 2 takes into consideration the fixed operating and maintenance charges on fuel storage, handling, preparation and burning equipment and indicates these charges for oil as being greater than for Pocahontas and about on a par with bituminous coal. This is not the case. Fuel oil unloading equipment consists of a suitable (about 8 in.) pipe line from the dock to the storage tanks and sometimes a 2-in. steam line. The pump is usually part of the barge equipment, and steam for pumping is often supplied by the tug doing the towing. Simple piping handles the fuel oil from a house tank, which is usually filled from storage by gravity, to the burners. A motor-driven rotary pump supplies fuel oil to the boilers. There is a great difference in favor of oil between the cost of operating this motor and the cost of reclaiming coal from storage, conveying, weighing, crushing, etc., that would be required if powdered coal were used, or the added cost of operation of stokers if they were used.

The latent heat loss when burning oil is appreciably lower than would be expected from Mr. Frisch's oil, due to the lower actual hydrogen content. All of the foregoing indicates that an oil-burning boiler plant should cost less than indicated in the paper under discussion, and the yearly cost of making steam, using oil, will show a better result than is indicated in Fig. 2.

M. H. CURLEY,

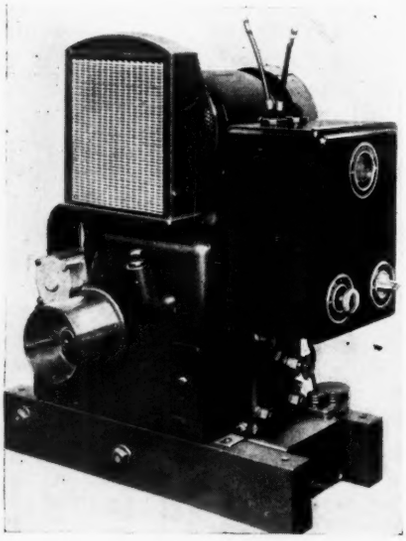
Bay Shore, N. Y. Long Island Lighting Co.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Self-Contained Lighting Plant for Auxiliary Service

TO MEET a growing demand on the part of small isolated industrial plants as well as isolated office building and hotel lighting plants for an economical source of power for light electrical loads during periods



Unit assembly with radiator and fuel tank

when the main generator is not or should not be operating, Fairbanks-Morse & Company, Chicago, have developed a compact, self-contained lighting plant that comes in two sizes, of 750 and 1,500 watts capacity, respectively. Such a unit is used to advantage to supply lights during the non-working hours as well as for emergency service. Also it may be used by contractors for a dependable source of power to supply illumination for night work. It is particularly adaptable for use on cranes, dredges and excavating equipment to supply illumination on jobs necessitating 24-hr. a day operation, independently of the main power unit. Another common use is in marine installations to provide light at such times as the boat is at anchor.

In the unit assembly the prime-mover is a Fairbanks-Morse self-oiling "Z" engine with high-tension magneto ignition. The smaller unit is designed to operate on gasoline as fuel, while the larger engine can use either gasoline or kerosene. The generator is a ball-bearing machine mounted directly above the engine, with a Flex-Mor V-belt drive. The control mechanism, contained in a completely inclosed box, is mounted on the main frame. It consists of a push-button start and a "high-low-belt" switch that permits the storage battery to be charged at a rapid rate for regular charges or at a low rate for an equalizing charge.

In the "belt" position the generator is disconnected from the engine, so that the entire power output is available for mechanical work from a pulley on the engine shaft. The usual storage battery plant starts with a simple push-button control, the generator acting as a motor during the starting period, so that no cranking is required. Ignition is supplied by a high-tension rotary magneto that is a complete generating unit in itself and entirely independent of the condition of the storage battery of the plant.

As will be evident from the photograph, the plant is water-cooled by a radiator, fan and water-circulating system similar to that used on automobile engines. The air-cooling system of the radiator is arranged to provide for the cooling of the generator. Both the 750- and 1,500-watt units can be had in voltages of 32 and 115. The floor space required is, height, 25½, 30½ in.; width, including crank, 23¼, 30¼ in.; length, 26, 32 in.; and the shipping weight, 275 and 500 lb., respectively. The charging rate at 32 volts is 18 to 22 and 34 to 42 amperes.

While this plant is built in two sizes only, it is offered with a variety of storage battery combinations that will meet almost any demand placed on the unit for either a 32-volt or standard 115-volt circuit. Either size can be furnished for direct lighting when it is desired to operate without the storage battery, in which case a special control panel is provided on which is mounted a voltmeter, ammeter and a field rheostat that permit voltage regulation of the generator to meet the demands of the load.

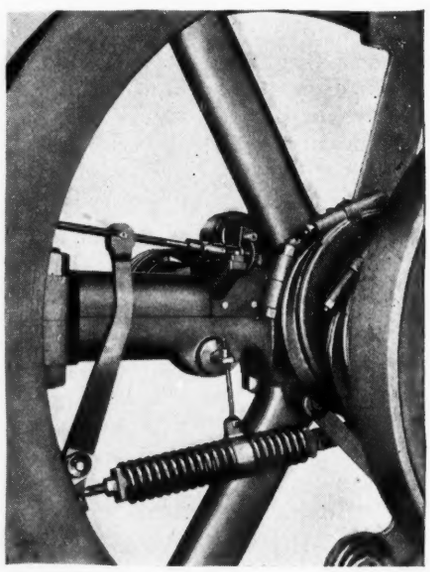
Flywheel Speed-Changing Device for Centrifugal-Inertia Governors

TO FACILITATE the synchronizing of two or more engine-generator units, the Mattoon Engine Works, Mattoon, Ill., successor to the Chuse Engine Manufacturing Company, has developed an electrically operated device consisting of a reversible-type motor mounted within the flywheel, which, through a worm and screw, changes the tension of the mainspring of the governor, thereby changing the speed of the engine.

The motor is controlled by a double-throw switch mounted on the main switchboard.

By this device the speed of the engine may be increased or decreased 5 per cent from normal speed without impairing the speed regulation of the engine.

This device may be applied to all Chuse uniflow and corliss engines using the centrifugal-inertia governor. No changes are required to be made on the present governor other than omitting the spring screw bracket in the rim of the wheel. Therefore, it can be used on engines now in operation.

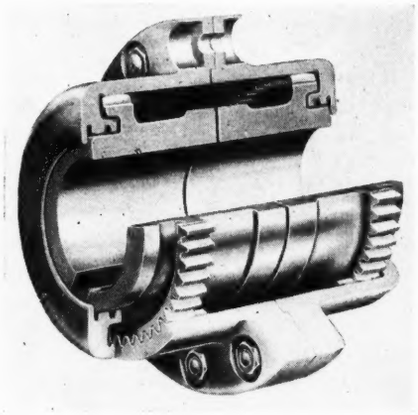


Speed-changing device mounted in position

Improved All-Metal Flexible Coupling

CERTAIN refinements in design have been made recently to the all-metal flexible coupling put out by the Poole Engineering Machine Company, Baltimore, Md. These features include the use of a combination dust-proof and centrifugal oiling feature, which is accomplished by a new type double flange end plate containing within its inner lip a deep felt packing for the exclusion of dust and dirt. The outer section is grooved and contains back drain holes, which permit lubrication of the coupling while in motion.

Another feature is the use of a special heat-treating process in the production of the coupling. Each part of the coupling is heat-treated to specifications. This tends to increase



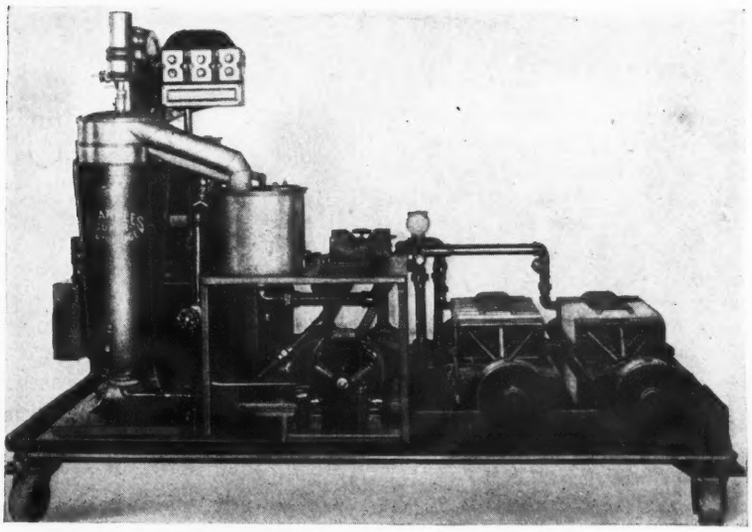
Cut-away view of coupling

the life of the coupling by giving protection against wear.

In this coupling (a complete description of which appeared in the March 9, 1926, number of *Power*) the load is carried on crowned gear teeth, formed on the periphery of each shaft hub, which mesh with corresponding teeth on the interior of a floating and connecting sleeve member. The gear teeth are submerged in oil when the coupling is in operation.

Large Capacity Oil Purifier and Filter Press

WHAT is said to be the largest portable combination centrifuge and filter press available is now being offered through the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. In this unit a Sharples super-centrifuge is combined with a Westinghouse filter press equipment and mounted



Combined oil purifier and filter press

on a truck. The capacity of the machine is 1,200 gal. per hour continuously.

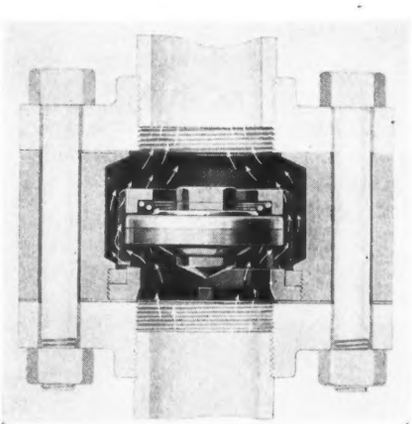
The unit is similar in design to the 900-gal. capacity unit made by the company and described in *Power* for Dec. 25, 1928. The piping of the machine is so arranged that the oil can be run through the centrifuge only and discharged without passing it through the presses. Electric heaters for raising the oil temperature to the proper point and push-button-type starters for controlling the operation of the purifier and pump motors are incorporated in the machine. The floor space required is approximately 54 x 106 inches.

Noiseless Check Valve

A NEW floating check valve that will operate noiselessly in any position for pressures up to 1,000-lb., with stream-line flow and all working parts removable and renewable, has been brought out by the valve division of the Williams Gauge Company, 343 S. Dearborn St., Chicago, and factory at Pittsburgh, Pa. A distinct advantage is the fact that it occupies only $2\frac{1}{2}$ to $4\frac{1}{2}$ in. in the line, for pipe sizes ranging from 1 to 6 in. diameter. Being built of metal to suit the service, it is applicable to use in vacuum heating systems, boiler-feed lines, house supply lines, air compressor lines, oil, gasoline and chemical lines. The manufacturer recommends it for centrifugal pumping service where noiseless operation is desired.

The check valve consists of a heavy cylindrical body of cast iron or steel with trim of government bronze or of nitralloy for higher temperatures and pressures. The valve mechanism, which the manufacturer has used successfully for the past eight years in a pump valve, consists of a three-point guide cage that screws into the body; a self-cleaning valve disk with tapered holder to guide the flow, a renewable seat that also screws into the body, and a beehive spring to hold the valve disk to its seat.

In assembled form, the valve seat following the guide has been screwed into the body until its outer face is flush with that of the body. The fit is loose to eliminate possible distortion of the body when the valve is subjected to heat. A flange gasket extending to the inner circumference of the seat covers the threaded joint between the body and seat, and, preventing corrosion or erosion, facilitates seat removal for refacing. At

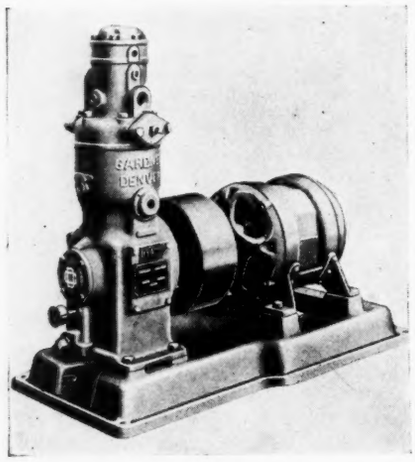


Check valve is inserted between flanges in the pipe line

the outlet end another gasket is used, and the complete assembly is bolted between two extra-heavy flanges in the pipe line. Sizes ranging from 1 to 6 in. are available, larger valves being made to order.

Two-Stage Vertical Compressor

LOW- and high-pressure cylinders and intercooler are combined in a single casting in the new two-stage air compressor of the vertical tandem

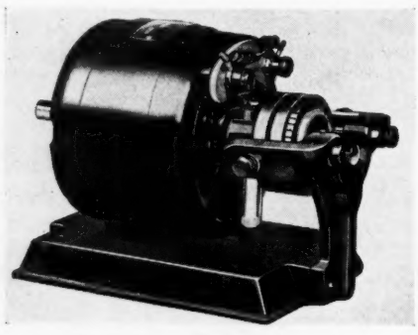


Compressor with direct-connected motor drive

type announced by the Gardner-Denver Company, Denver, Colo. The compressor, which weighs 350 lb., is designed to give 24 cu.ft. of air per minute at pressures up to 500 lb. Main bearings are of the roller type. Lubrication is effected by a combination oil pump and splash system. The compressor can be furnished with pulley for V-belt drive or for direct connection to an electric motor, steam or gas engine. It is particularly suited for oil and gas engine starting purposes and other services requiring small volumes of air at moderately high pressures.

Motor-Driven Polarity Changer

A MOTOR-DRIVEN contact maker for converting direct current to alternating current by reversing the direct current through a special commutator is a recent development of the Bodine Electric Company, 2254 W. Ohio St., Chicago. Direct current is fed to the commutator through a pair of slip rings and the output is taken from brushes in contact with the commutator.

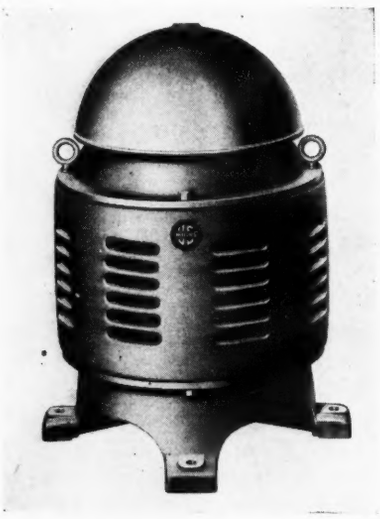


Machine changes direct current to alternating current

The motor can be wound for any alternating or direct-current voltage and has no electrical connection with the slip rings or commutator. For certain work, the commutator is designed to give an alternating current of 360 cycles per second or higher if necessary. The same equipment can be used for selective frequency ringing or for any purpose requiring an alternating current. The units are made in capacities of 100 watts or higher.

Turbine Pump Motor of Symmetrical Design

A TYPE of motor designed especially for use with turbine centrifugal pumps requiring vertical motors has been brought out by the United States Electrical Manufacturing Company, Los Angeles, Calif.



Motor for vertical turbine pump

In many cases heretofore, the base of the pump, which rests upon the concrete at the surface of the ground on this particular type of unit, has been designed by the manufacturer to suit his needs, resulting in a rather awkward assembly and a unit which in general design was not in keeping with good engineering practice.

This condition is obviated in the new motor, illustrated, introduced especially for this class of service. It is symmetrically designed with all the operating parts fully protected. The motor is available in a number of sizes to meet practically any installation requirement.

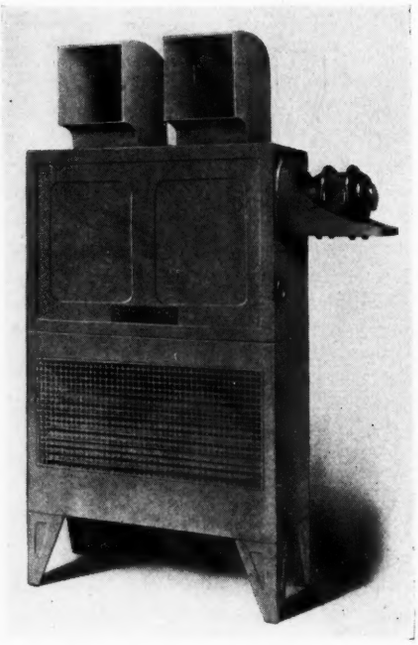
Unit Heater That Washes and Humidifies

A RECENT addition to the line of unit heaters put out by the Buffalo Forge Company, Buffalo, N. Y., is the air-washing and humidifying unit, designated "Wetboy," illustrated.

With the exception of the humidifying section, the new unit is similar in detail to the other two models of heaters put out by the company. The air is drawn through the unit by multi-rotor fans of the centrifugal type, each in its own fan housing. The complete rotor and shaft assembly can be removed through the end plate without disturbing other parts of the heater. The motor bracket end plate and the outboard end plate are interchangeable, so that the fan can be placed on either end. The heating elements are of Aerofin tubing, suitable for pressures from 2½ to 200 pounds.

The washing and humidifying element consists of a revolving drum (air washer eliminator and scrubber plates) propelled by the air current through the unit. The scrubber plates continually drip in the water tank and provide wetted surfaces through which the air must pass twice. No auxiliary or circulating pump is used.

The dirt picked up from the air settles into the tank, from which it is removed at intervals by flushing through a drain connection.



"Wetboy" unit heater with air washing, humidifying and heating element

Basic Steam Tables Made Public

IN OFFICIAL REPORT OF LONDON CONFERENCE

DURING the week commencing Monday, July 8, there was held in London a conference of various physicists and engineers who are engaged in the experimental determination of the properties of steam or in the organization of the work. At this conference, which was convened by the British Electrical and Allied Industries Research Association, there were present the following, all of whom are interested in one or other phase of the investigation of the properties of steam:

America

DR. HARVEY N. DAVIS, president of Stevens Institute, Hoboken, N. J.
DR. DICKINSON, Bureau of Standards, Washington, D. C.
PROF. J. H. KEENAN, Stevens Institute, Hoboken, N. J.
MR. GEORGE A. ORROK, consulting engineer, New York City.
MR. NATHAN S. OSBORNE, Bureau of Standards, Washington, D. C.

Great Britain

PROF. H. L. CALLENDAR, F. R. S., and MR. G. S. CALLENDAR, Imperial College of Science and Technology, South Kensington, London.
PROF. W. A. DALBY, F.R.S., City and Guilds (Engineering) College, London.
MR. H. L. GUY, Metropolitan-Vickers Electrical Co., Ltd., Manchester.
MR. I. V. ROBINSON, British Electrical & Allied Manufacturers' Association, London.
MR. F. SAMUELSON, British Thomson-Houston Company, Ltd., Rugby.
DR. G. C. STONY, F.R.S., C. A. Parsons & Company, Ltd., Newcastle.

Germany

DR. H. HAUSEN, Gessellschaft für Lindes Eismaschinen, A. G., Munich.
PROF. DR. M. JAKOB, Physikalisch-Technische Reichsanstalt, Berlin.
GEHEIMRAT PROF. DR. O. KNOBLAUCH, Technical High School, Munich.
DR. W. KOCH, Technical High School, Munich.
GEHEIMRAT PROF. DR. R. MOLLIER, Technical High School, Dresden.

Czechoslovakia

DR. J. HAVLICEK, Witkovitz Iron & Steel Works.
PROF. MISKOVSKY, The University, Prague.

Invitations were also sent to Professor Stodola, of Zurich, who was prevented by ill-health from attending, and to Prof. F. G. Keyes, of the Massachusetts Institute of Technology, Boston, who was unable to spare the necessary time.

The conference was opened on Monday, July 8, by Dr. Daniel Adamson, president of the Institution of Mechanical Engineers, and was continued under the chairmanship of Sir Richard Glazebrook, F.R.S.

At the start of the conference a general description of the apparatus that they had used was given by the different investigators, and certain information was exchanged regarding the methods adopted for correcting or limiting various errors.

A discussion then took place as to the form in which the final recommendation of the conference should be presented. All delegates agreed that the best solution would be to draw up, in skeleton form, a small table of the properties of steam. To determine each figure to be inserted in the table, suggestions would be made by each of the four countries represented and a mean figure would be adopted together with a tolerance of an agreed magnitude. It was recognized that in some parts of the table the necessary tolerance might be relatively large due probably to the different types of apparatus used by the various investigators giving results departing systematically from the results of other investigators.

A small committee was therefore appointed to consider this proposal in detail and to prepare the desired skeleton tables. This committee consisted of the following: Dr. Davis (with the assistance of Professor Keenan), Mr. Callendar, Professor Miskovsky, Dr. Jakob and Dr. H. Hausen.

This is believed to be the first publication in America of the official report of the international steam table conference held last July in London. The report, which reached Mr. Orrok of the American group, early in December, was made available through the courtesy of *Mechanical Engineering*. The "international" skeleton steam tables and the new heat unit here presented represent important forward steps in the codification of steam research.

Mr. Robinson was appointed chairman of this committee.

Scope of Skeleton Tables

It was decided by the committee, as regards the saturated steam table, to take eight temperatures varying by steps of 50 deg. C. from 0 deg. C. to 350 deg. C. and to determine for each temperature the following properties: saturation pressure, specific volume of the liquid, specific volume of the vapor, total heat of the liquid, and total heat of the vapor.

For the superheated steam tables it was decided to take a number of pressures varying from 1 atmosphere up to 250 atmospheres and to tabulate, for temperatures varying by intervals of 50 deg. C. or 100 deg. C., the specific volume and total heat of the steam.

Units and Conversion Factors

In these skeleton tables the following units are used:

Length, meters; specific volume, cubic meters per kilogram; pressure, kilograms per square centimeter; temperature, degrees Centigrade; total heat, International kilocalories, which by definition equals—kilowatt-hour ÷ 860.

In any international comparison of physical data, an element of doubt is introduced by the small differences in the basic units employed in each country, and it was appreciated by the committee that the units to be employed would have to be considered carefully and stated clearly. Their recommendations are herein detailed and their *raison d'etre* briefly explained.

Pressure Conversion Factor

In obtaining the conversion factor for pressure per unit area from the metric to the foot-pound-second system, and vice versa, the following have been assumed as basic figures—

1 pound = 453.5924 grams
1 inch = 2.54000 cm.

With these values

1 kg. per sq.cm. = 14.223334 lb. per sq.in.

In connection with this point it should be noted that the metric equivalent of the inch employed is intermediate to the British and American legal values. These values are—

American: 1 inch = 2.540005 cm.
British: 1 inch = 2.539996 cm.

The American value is based upon the definition that the meter is 39.37/12 of a foot, while the British value is the result of latest comparison of the standard meter and standard yard, this comparison having been made in 1922-24. This slight difference has no appreciable effect upon the pressure conversion factor, as, if calculated upon the respective metric equivalents, this would be:

British: 14.223329 lb. per sq.in.
American: 14.223340 lb. per sq.in.

The adopted value, 14.223, is, therefore, accurate to five significant figures on either the British or American basis, and has been used for the preparation of these tables.

In considering the relation between the pound and the gram, expressed above, the value of "*g*" does not enter into the calculation beyond ensuring that the same value is used throughout. It is, however, desired to record that the

standard value of 980.665 cm. per second per second has been used.

Specific Volume Conversion Factor

Based upon the equivalents previously quoted for the inch and the pound, the factor, to obtain cubic meters per kilogram from cubic feet per pound, is

$$\frac{(12 \times 2.54)^3}{0.433592 \times 10^6}$$

This is equal to 0.0624279, and the value of 0.06243 has been used as being sufficiently accurate. So that we have:

1 cubic foot per pound = 0.06243 cubic meters per kg.,

or, reciprocally:

1 cubic meter per kg. = 16.0184 cu.ft. per pound.

Heat Units

Before the appointment of the committee, the conference considered carefully the units in which the total heat was to be recorded. It was felt to be desirable that the adopted unit should be one that would avoid any complication due to the variation in the acceleration of gravity in various parts of the world or the variation of the specific heat of water with temperature; and also that it was desirable to avoid a definition that involved a change in the value of Joules' equivalent with each improvement in calorimetric technique. It was pointed out that electrical units were independent of both g and j, that they were known accurately within narrow limits and were internationally accepted, and that, therefore, it would be desirable to secure the general acceptance of a calorie defined in terms of the watt-hour.

This unit, the kilocalorie, should actually not differ greatly from the heat units used up to the present time and should be obtained from an electrical unit by means of a conversion factor that is easily remembered.

A unit defined by the heat equivalent of an international kilowatt-hour divided by 860 meets these claims, and it was accepted by the conference as a basic unit for these tables. It is recommended that it should be designated as the international kilocalorie.

The international kilocalorie differs from the kilocalorie used up to now in various countries by less than plus or minus 0.05 per cent, which is an insignificant amount. It has, however, the great advantage of being independent of the determinations of the electrical heat equivalent, which differ slightly from one another.

In his work Professor Callendar has used the mean calorie with a value of 4.185 Joules. The German investigators have used the 15 deg. C. calorie with a value of 4.184 Joules, while the American investigators have used the new Bureau of Standards value for the mean calorie (4.1876 Joules), whereas the unit as defined above has a value of 4.186 Joules.

International Temperature Scale

The conference adopted the international temperature scale, which, as is well known, is determined by the temperature of the ice point, the temperature of ebullition of water under a normal metric atmosphere and the boiling point of sulphur 444.60 deg. C., also under a normal metric atmosphere.

Definitions of Saturated Pressure at 100 deg. C.

On the constant volume hydrogen thermometer scale, a temperature of 100 deg. C. is defined as the temperature of the vapor of distilled water in ebullition under a pressure equal to a normal metric (physical) atmosphere. This, in turn, is defined as the pressure corresponding to a column of mercury 76 cm. in height under standard gravity conditions, that is, $g = 980.665$ cm. per second per second and at 0 deg. C. The density of mercury at 0. deg. C. being 13.5955 grams per cubic cm., the normal physical atmosphere pressure is 1033.-258, or, say, 1033.3 grams per square centimeter. Thus the saturation pressure at 100 deg. C. is defined as being 1.0333 kg. per square centimeter under standard gravity conditions. This is, therefore, not an agreed value but a definition and as such needs no tolerance.

Definition of Heat Liquid at 0 Deg. C.

The one other definition that has to be mentioned is the total heat of the liquid at 0 deg. C. It has always been the custom of all investigators and authors of steam tables to define the total heat of a liquid or vapor as the content in excess of that contained by the liquid at 0 deg. C. and saturation pressure. This latter content is, therefore, zero by definition.

Compilation of Skeleton Tables

Dealing now with the actual determination of the figures to be inserted in the skeleton tables, each delegation calculated from the determinations of its own members some or all of the figures required for the tables, and these were then compared carefully. In deciding upon the figures to be inserted in the skeleton tables, based upon the various national proposals, due consideration was given to the method in which the figures had been determined. More weight was attached to the figures which were the result of direct experiment than to those which were merely an extrapolation from other work.

SKELETON TABLE FOR SATURATED STEAM

(M.V. = mean values; Tol. = Tolerances)

Temperature Deg. C.	Pressure Kg. per Sq. Cm. M.V.	Pressure Kg. per Sq. Cm. Tol.	Specific Vol. of Liquid, Cu. m. per Kg. M.V.	Specific Vol. of Liquid, Cu. m. per Kg. Tol.	Specific Vol. of Vapor, Cu. m. per Kg. M.V.	Specific Vol. of Vapor, Cu. m. per Kg. Tol.	Total Heat of Liquid Int. Kcal. per Kg. M.V.	Total Heat of Liquid Int. Kcal. per Kg. Tol.	Total Heat of Vapor, Int. Kcal. per Kg. M.V.	Total Heat of Vapor, Int. Kcal. per Kg. Tol.
0	0.00623	0.00001	0.00100	0.00000	206.4	0.1	0.00	0.00	595.4	1.2
50	0.1258	0.0001	0.00101	0.00000	12.06	0.01	49.95	0.02	618.5	1.0
100	1.0333	0.0000	0.00104	0.00000	1.674	0.001	100.04	0.02	639.2	0.5
150	4.854	0.002	0.00109	0.00000	0.393	0.001	150.93	0.03	656.0	1.5
200	15.85	0.01	0.00116	0.00000	0.1270	0.0006	203.6	0.04	667.5	2.0
250	40.60	0.05	0.00126	0.00001	0.0501	0.0002	259.5	0.3	670.0	3.0
300	87.7	0.1	0.00142	0.00001	0.0218	0.0005	321.8	1.0	657.5	5.0
350	168.7	0.1	0.00179	0.00003	0.0089	0.0002	403.7	2.0	617.0	7.0

SKELETON TABLE FOR TOTAL HEATS OF SUPERHEATED STEAM

(M.V. = mean values; Tol. = Tolerances. Total heats mesured in Int. Kcal. per Kg.)

Temp. Deg. C.	Pressures in Kg. per Sq. Cm. 1 M.V.	1 Tol.	5 M.V.	5 Tol.	10 M.V.	10 Tol.	25 M.V.	25 Tol.	50 M.V.	50 Tol.	100 M.V.	100 Tol.	150 M.V.	150 Tol.	200 M.V.	200 Tol.	250 M.V.	250 Tol.
100	639.4	0.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
200	687.5	1.0	682.5	1.5	676.2	1.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
300	735.3	1.5	732.5	2.0	729.5	2.0	719.8	1.5	700.6	2.5	.....	.....	.....	.....	.....	.....	.....	.....
400	783.4	1.5	781.7	2.0	780.0	2.0	774.4	1.5	764.0	2.6	741.7	3.0	713.9	3.0	676.0	2.5	622.0	4.0
450	807.7	1.5	807.0	2.0	805.0	2.0	800.5	1.5	793.5	2.0	776.3	3.0	757.7	3.0	736.0	4.0	712.0	6.0
500	832.6	1.5	831.6	2.0	830.2	2.0	827.7	2.0	822.0	3.0	809.5	3.0	797.5	4.0	784.0	6.0	769.0	8.0
550	858.0	2.0	857.5	2.0	856.5	2.0	853.8	2.5	850.0	5.0	840.0	5.0	832.0	5.0	823.0	8.0	812.0	10.0

SKELETON TABLE FOR SPECIFIC VOLUMES OF SUPERHEATED STEAM

(M.V. = mean values; Tol. = Tolerances. Specific volumes measured in cu.m. per kg.)

Temp. Deg. C.	Pressures in Kg. per Sq. Cm. 1 M.V.	1 Tol.	5 M.V.	5 Tol.	10 M.V.	10 Tol.	25 M.V.	25 Tol.	50 M.V.	50 Tol.	100 M.V.	100 Tol.	150 M.V.	150 Tol.	200 M.V.	200 Tol.	250 M.V.	250 Tol.
100	1.730	0.003	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
200	2.213	0.004	0.4331	0.0006	0.210	0.0002	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
300	2.689	0.005	0.5326	0.0006	0.2631	0.0003	0.1011	0.0003	0.0465	0.0004	.....	.....	.....	.....	.....	.....	.....	.....
400	3.160	0.005	0.6294	0.0006	0.3125	0.0003	0.1224	0.0003	0.0591	0.0004	0.0271	0.0004	0.0162	0.0003	0.01028	0.00005	0.00636	0.00005
450	3.396	0.005	0.6783	0.002	0.3367	0.0003	0.1327	0.0003	0.0645	0.0004	0.0305	0.0004	0.0190	0.0003	0.01312	0.00025	0.00940	0.00015
500	3.632	0.005	0.7242	0.002	0.3604	0.0004	0.1426	0.0003	0.0698	0.0004	0.0334	0.0004	0.0212	0.0004	0.01512	0.00035	0.01136	0.00030
550	3.868	0.005	0.7720	0.002	0.3846	0.0004	0.1523	0.0004	0.0749	0.0005	0.0361	0.0005	0.0232	0.0005	0.01673	0.00045	0.0130	0.0004

The figures thus inserted in the table did not represent a mechanical averaging of the national figures but were the result of a careful consideration of the relative values of the different proposals. In this way the figures given in the table and the tolerances attached to each figure were obtained. These values were unanimously accepted by the conference as representing the first stage in their deliberations.

Since the conclusion of the conference each delegate has verified or corrected the figures submitted in the committee, and the skeleton steam tables are based upon the confirmed figures.

Further Investigations

Those figures for which it was found necessary to allow a comparatively large tolerance were recognized as presenting special difficulties and requiring further detailed experimental investigations. It is hoped that as a result of this further investigation the figures might be varied at a later conference so that the range of national values for any one figure may be reduced and, consequently, the tolerances also reduced. In addition, at such further conference values for a larger number of pressures and temperatures may be inserted.

With this step-by-step method of improving the skeleton table and reducing the tolerances, it is hoped that it may be possible in a comparatively short time to get a skeleton table that is accurate within very small margins and accepted by all recognized authorities.

Thermodynamic Consistency

The committee and the conference were quite clear that on account of the method employed in setting up the skeleton tables the values adopted for the total heat and for the specific volume might not be thermodynamically consistent in the strict scientific sense, since, according to theory, all other values can be derived from only two quantities of state (for instance temperature and pressure), if a perfectly correct equation of state is available. It is also possible that for given values of the pressure and temperature, the values of the specific volume and total heat in the tables might contradict each other. By the choice of large tolerances, however, such a contradiction should virtually be excluded.

Should, in the meantime, any nation represented at the conference, or, it is hoped, others not so represented, desire to produce further steam tables, these should be so calculated that they give values for any property in the steam table coming within the range of tolerances given for that property in the skeleton tables, as there would be considerable doubt as to the accuracy of any figures falling outside this range of tolerances.

It has been felt desirable that some explanation should be given of the methods used in arriving at the figures given in the skeleton tables. The idea of a tolerance in regard to the properties of steam is novel, but is well suited to the present circumstances.

Progress of Welding in the Power Plant Field

Each year a special committee of the International Acetylene Association surveys progress in the welding field, with particular reference to gas welding. Reproduced here is the section of this year's report, outlining welding progress in the power field.

IN LAST year's report appeared an extensive tabulation of the principal uses of welding in connection with the generation, transmission and application of the power services. The table shown there still represents the power applications of welding except that a steady, healthy growth in use is to be noted all along the line.

To sound recent trends, statements have been secured from a number of prominent engineers in public utility and industrial plants and in the consulting and contracting fields.

A well-known specialist in power and industrial piping write as follows:

"It has been my observation that while autogenous welding took a great spurt some years ago, in the days of its early usage, and then a great many faults were found with it, it is now, on the contrary enjoying a gradual, sound, safe and sane growth. Engineers today, while they are not specifying welding to a very great extent outright, because of the fact that they can never be sure about the welding ability of the final contractor who is chosen, are, nevertheless, allowing responsible contractors who they know have trained pipe welders to do welding almost wherever they find it economical.

"I think it is safe to say that there is scarcely a power plant installation of any size today where the piping contractor does not have a welder and welding equipment on the job. He is finding that this is one of his most needed and efficient tools. In low-pressure materials, even though he is not doing an all-welded job, he can cut and fit to meet conditions that some years ago caused great delays and expense.

Some of the large utility companies still take a conservative attitude toward the welding of high-pressure steam lines, although others have used them with success for years. It is a problem of the welding industry to show these companies how they may be certain of sound welds.

Outside of high-pressure steam lines, practically all plants, utility and industrial, make extensive use of welding for a variety of piping, ducts, machine repairs, etc.

An engineer with a prominent firm of power plant contractors, writes:

"It is my experience that the use of welding in all classes of piping is increasing very rapidly. Not so very long ago when welding was mentioned the question always came up as to whether it would be satisfactory, but now the question is seldom raised and the welded work goes in.

"We have used it on long high-pressure steam lines, and on one large heating system the contractor welded all the piping even down to the small return pipes."

The power engineer of a very large chemical plant writes as follows:

"I am appalled by the cost of maintaining a sulphate alkalinity ratio in high-pressure boilers with riveted drums. In welded or forged steel shells, based on our experience, I would be willing to disregard the sulphate alkalinity ratio entirely."

Along the same lines, the engineer of a large utility plant writes:

"Autogenous welded drums are undoubtedly imminent. The widespread adoption of high steam pressures has created a large demand for forged drums, and it is probable that eventually welded drums will replace the solid forged drums. This also applies to high pressure headers, which are exceedingly expensive when made in small diameters and long lengths required for high-pressure installations.

An engineer with an engineering and construction company writes:

"There is a slow increase in the use of welding in power plant applications, which now takes this means of fabrication beyond the piping field. Pressure vessels of larger size, such as steam separators, are now quite frequently welded. There is one instance of a condenser welded up of plate steel, and I expect to see feed-water heaters added to the list. I have no doubt that inside of the next five years we shall see welding used in place of riveting for nearly all pressure vessels.

"In the oil industry, autogenous welding has been used extensively for several years for all kinds of pressure vessels. So far, the results have been a great improvement over the riveted construction, as, under the severe temperature strains in stills and similar apparatus, the joints could not be kept tight and had to be seal welded."

When and if boiler drum welding is permitted, the requirements as to procedure control and inspection will undoubtedly be extremely rigid. In view of the type of service, this is but natural. Nothing but the finest work can be allowed in boiler construction.

Another opening field for welding in the power plant is in the fabrication of condenser shells and exhaust hoods of turbines. These huge structures, now made of cast iron, can undoubtedly be constructed much more cheaply of welded steel. A start in this direction has already been made.

Refrigerating Engineers Celebrate Twenty-fifth Birthday

THE American Society of Refrigerating Engineers celebrated the twenty-fifth anniversary of its founding, at the annual meeting in New York City, Dec. 4 to 7.

The opening feature, after the council meeting, was a luncheon on Wednesday, at which Col. R. I. Rees, president of the Society for the Promotion of Engineering Education, was the principal speaker. Colonel Rees pointed out that there is a grave problem in the proper placing of young engineers in industry. The speaker stated that he has no sympathy with the current idea that the young graduate must start at the very bottom of the business ladder. The graduate's educational training justifies a more advanced place in an organization. He must be shown that his initial and subsequent jobs lead to a definite goal. Every organization should provide some educational stimulus for its young engineers, such as advanced courses in its particular science or art.

At the first of the technical session, on Wednesday afternoon S. C. Bloom, Chicago, Ill., assumed the rôle of a seer and prophesied on "The Next Ten Years in the Refrigeration of Food." His paper dealt with the probable advances in refrigerating machine design. It is his opinion that machine builders are making a mistake in constructing compressors of the slow-speed, heavy design, entailing a high manufacturing cost. He advanced the idea that machines should be built and operated with the expectation that a short life was to result. This being true, the compressor should be of the high-speed multi-cylinder design, to enable it to be direct connected to an 1,800-r.p.m. motor. He predicted that the refrigerating engineer will give most of his attention to industrial refrigeration in the future, for the day is coming when large office buildings, theaters and hotels and many homes will be artificially cooled in summer.

The second paper, "Use of Corrugated Fibreboard Shipping Containers," by Clarence Birdseye, General Foods, Inc., covered the construction of the containers used in transporting frozen fish. In the early days of the frozen-fish industry it was thought that a balsa-wood box was necessary to provide sufficient resistance to heat absorption during transit. The expense of this box almost ruined the industry. The author of the paper tested various box materials. He found that the insulation quality of fiberboard is high, and his company now ships fish in fiberboard boxes lined with several inches of corrugated fiberboard sheets. These boxes, holding 20 lb. of fish, cost about 25c., and are discarded by the customer.

Other papers presented during this meeting were "The Report on Refrigerant Research," by E. F. Mueller, Bureau of Standards, and "The Production of Low Temperatures by the Desorption of Gases by Charcoal," by R. H. Andrews, R. K. Witt and Elizabeth A. Grigen, Johns Hopkins University.

The second technical session was devoted to problems of household refrigeration.

In the third session, Thursday morning, Charles C. Small, American Ice Company, dealt with "The Ice Industry Today." In spite of the inroads of the household refrigerating machines, the speaker was of the opinion that the ice industry is in comfortable circumstances. The increased number of families using ice had more than offset the sales loss due to household machines.

> THE refrigerating engineer of the future will be more concerned with industrial refrigeration than with ice making. Hotels, office buildings, factories, and homes, will be artificially cooled.—S. C. Bloom.

"Plant Reconstruction" was the subject of an extensive paper by H. L. Lincoln, Union Ice Company, San Francisco, Calif. The author, however, was unable to be present. This paper will be published in a later issue of *Power*.

In his paper, "Trends in Refrigerating Engineering," Fred Ophuls, consulting engineer, New York City, stated that the chemical industry and lower temperature requirements of new processes are bringing CO_2 refrigeration into prominence. For such places as theatres, hotels and office buildings, the odorless and non-toxic characteristics of carbon-dioxide make it highly desirable as a refrigerant. He also touched upon the safety code prepared by the A.S.R.E. and recommended that engineers design new plants so that the code will be met. He also pointed out that better heat-exchange equipment is needed, as is better design of compressors.

In his paper, "The Electrically Driven Ice Plant," Harry Sloan, Vilter Manufacturing Company, discussed the proper arrangement of motor-driven compressors and auxiliaries. Estimates of the probable cost of electricity per ton of ice manufactured were given.

In the Friday morning session a paper by Guy V. Thompson, on "Practical Methods of Corrosion Prevention," was read by George Lang, chief engineer, Knickerbocker Ice Company. This paper dealt with the methods adopted by the Knickerbocker Ice Company to prevent corrosion of brine tanks. Following the suggestions of the A.S.R.E. Corrosion Committee, bichromate of soda has been used with entire success, when employed in conjunction with zinc dust.

In the mixing of water and calcium to make a brine, it is best to cool the water down to about 35 deg. F. before adding the salt. This prevents the corrosion that occurs when the salt is added to warm water. It is necessary to maintain the brine at the neutral point, with a pH value of 8. If it is above this value, the cans begin to lose the zinc coating. Mr. Lang pointed out that silica of soda will not prevent corrosion save with fresh water.

George A. Horne, vice-president, Merchants Refrigerating Company, New York City, in a paper on "A Test of a Two-Stage Double-Inlet Compressor," described the procedure followed in making a test on a compressor installed in a cold storage plant. This test followed the A.S.R.E. code, showing that the code has a practical value.

The two-stage compressor is unusual, in that the two ends of each cylinder handle different pressures. The cylinders are 13 in. and 15 in. in diameter. The crank end of each cylinder handles suction vapor at 5 lb. gage, while the head end of the 13-in. cylinder handles a high suction vapor at 20 lb. gage. The discharge from these three ends passes into an intermediate cooler and then into the head end of the 15-in. cylinder. It was discovered that the valve areas were not sufficient to prevent a wire drawing defect now being remedied. The mechanical efficiency of the compressor was found to be 87.9 per cent at 200 r.p.m. The compressor efficiency averaged 79.2 per cent for the entire machine. The electrical horsepower of the compressor was 1.41 per standard ton of refrigeration.

The joint session with the A.S.M.E. was followed by the annual banquet Friday night and the final technical session

Saturday, at which Crosby Field was the principal speaker. He stated that engineers after leaving college have opportunities to get into business far greater than did graduates of twenty years ago. Business no longer fears higher education. Many openings await the engineer who can introduce new methods or new products. Today the engineer is no longer occupied solely with design problems, but is engaging in selling and financing.

The Saturday session of the convention was devoted entirely to an open forum discussion on the general subject of research. H. H. Harrison, chairman of the Research Committee, presented the carefully developed policies of his committee, covering three particular activities. The first is fundamental research, to be sponsored by the society in its entirety, such as the past investigations of ammonia at the Bureau of Standards and the present work there on carbon dioxide. The second class of investigation, according to the views of the committee, consists of subjects of more immediate, though less permanent, value, such as is carried on by companies and colleges on the materials and machinery of refrigeration.

In general, the society has not had any specific charge of such work. Only in event of a particular problem has this type of work been promoted, for example, the corrosion research, in which the society took the leading part with the ample support of other agencies—companies and trade associations—in the business. The subject was discussed by the chairman of the meeting, President A. J. Wood, who had, he stated, been in wide contact with manufacturers in this field, only to become more and more sure that the refrigerating industries are not forging ahead into unknown fields of technical knowledge as are others. Several suggestions were made from the floor, such as studies of refrigerant properties, foods, materials used in refrigerating machines, such as metals and oils, effect of refrigerants on the human body, the pathological benefits of air conditioning, and others.

David L. Fiske, secretary of the A.S.R.E., discussed at length the policy upon which any co-operative research should, in his opinion, be based. According to him, most of the problems engineers want solved should be solved by them, at their own or their company's expense, for they fall in the class of invention rather than research. Moreover, another limitation must be placed upon the selection of subjects for research financed by contributions, in that each job is too big for any one agency to conduct alone.

The result is, according to him, that the only proper studies in which a technical society can take the lead are likely to be of a very fundamental sort, requiring a great deal of time and money for their solution. He felt, however, that it was up to the technical men to lead the way in all lines of investigation, to determine what problems did need to be studied, find those who would profit by the results and solicit their funds, and to administer the research fund—a job requiring as much skill as that of actually performing the work in the laboratory.

WINNERS of the Student Research Work Prizes awarded at the annual A.S.R.E. meeting were: Martin R. Borgar, Pennsylvania State College; Charles Keevil, Massachusetts Institute of Technology; John C. Reed, University of Illinois; and E. J. Tavanlar, Yale University.

A feature of the Saturday session was the presentation by H. H. Harrison, Brunswick Kroeschall Company, of the four A.S.R.E. prizes for student research work. These papers were "Heat Transmission in the Refrigerating Industry," by Charles Keevil; "Rural Refrigeration," by Martin Borger; "The Flow of Superheated Ammonia in Pipes," by John C. Reed," and "Lubrication Test With a Rotary Compressor," by E. J. Tavanlar.

In making the awards the committee judged mainly the result—the value of the paper, and the knowledge shown. The first prize, of $200, was awarded to the paper from Illinois; a second, of $75, to the representative from M.I.T.; while two third prizes were given to the two other contestants whose papers were accepted.

New Officers

The officers for 1930 took office at the close of the convention. H. D. Edwards, consulting engineer for the Linde, Prestolite and Union Carbide companies, is now president, and A. H. Baer, Frick company, first vice-president. The second vice-president's office is now filled by Glenn Muffly, of the Copeland company. New members of the board of directors include: C. F. Belshaw, Detroit; J. B. Churchill, New York; A. R. Stevenson, Jr., Schenectady, N. Y.; and L. L. Lewis, Newark, N. J. The society decided to hold the 1930 spring meeting in Atlanta, Ga., in May.

A.S.M.E. Speakers Hail Statistics As an Engineering Fundamental

OF LATE years, engineering, no longer content with applying physics and chemistry to practical ends, has been exploring other fields in search of scientific fundamentals that may be made effective tools of practical engineering operation. Among these, economics and cost accounting have been outstanding.

Perhaps the science of statistics will be the next to contribute noticeably to engineering. Such at least was the impression gained from penetrating comments made at a round-table conference on analysis and presentation of data held in connection with the recent annual A.S.M.E. meeting.

This was a joint meeting of the A.S.M.E. and the American Society for Testing Materials. The science of statistics was competently represented by experts in this field both within and without the engineering profession. It was pointed out that engineers, through their technical societies and commercial enterprises, are spending millions in the collection of data, but that a substantial portion of this expenditure is wasted through failure to analyze and present the data properly. This is fundamentally a statistical problem.

So far, perhaps the greatest application of statistical methods to engineering problems has been in the field of communication. It was therefore not unnatural that men connected with the American Telephone & Telegraph Company and the Bell Telephone laboratories played a prominent rôle in the conference. Colonel Rorty of the A.T.&T. presided.

Dr. Wilson, president of the American Statistical Association besought the co-operation of the A.S.M.E. and A.S.T.M. on problems involving statistics as well as engineering. The practical application of statistics, said Dr. Wilson, has been confined too much to such fields as economics and sociology. He hoped to see a great extension of its application in engineering, biology, astronomy and many other fields.

Dr. W. A. Shewhart of the Bell Telephone Laboratories said that the engineer must follow the footsteps of physicists in turning to statistics. Statistical theory, he pointed out, is but an extension of the theory of probability. Its practical utility lies in the fact that nothing is certain except uncertainty and that statistics and probability represent the most practical approach.

He spoke of the absurdity of the term "constant" as applied in many of the quantities in which the engineer deals. The engineer looks up the tensile strength of steel or of southern pine in his handbook and seems to assume that this is the strength of the material, when it is certain that any actual specimen will either be stronger or weaker. The amount and distribution of this possible excess or shortage is fully as important as the so-called "mean value." The remedy, said Dr. Shewhart, is to present, not "constants," but a statement of the distribution of values.

FROM AMONG READERS' PROBLEMS

Conducted by L. H. MORRISON

EQUIVALENT EVAPORATION—*In looking up the equivalent evaporation from feed water at 220 deg. F. into steam at 150 lb. gage, I found the value given as 32.79 lb. per boiler horsepower. How is this calculated?* J. T. C.

Boiler horsepower is an obsolete term, taken as the evaporation of 34.5 lb. of water "from and at 212 deg. F.," meaning that the feed water is at 212 deg. F. and is evaporated into steam at atmospheric pressure, or zero gage, the temperature remaining at 212 deg. F.

This calls for the addition of 970.4 B.t.u. Feed water at 212 deg. F. has a heat content, measured from that of water at 32 deg. F., of 180 B.t.u. per pound and after evaporation into dry saturated steam at 212 deg. F. and zero gage pressure the total heat in the steam is 1,150.4 B.t.u. per pound. The difference is that added, namely 1,150.4 —180 = 970.4 B.t.u.

Feed water at 200 deg. F. has, so the steam tables show, a heat of the liquid of 167.9 per pound measured from 32 deg. F. A pound of steam at 150 lb. gage, or 164.7 lb. abs., has had added to it a total of 1,145.8 B.t.u. measured from water at 32 deg. F. The difference of 1,145.8 — 167.9 = 977.9 B.t.u. per pound is that added if the feed water is at 200 deg. F.

The "factor of evaporation" is 977.9 ÷ 970.4 = 1.0077. If you desire to find the equivalent evaporation in terms of boiler horsepower, you must consider that a boiler horsepower is the evaporation of 34.5 lb. of water from and at 212 deg. F. With feed water at 150 deg. F. and a steam pressure of 150 lb. gage, it will require 34.5 ÷ 1.0077 = 34.23 lb. to equal a boiler horsepower.

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ECONOMIC HEATING BOILER PRESSURE—*I am heating a four story building that fills an entire block, by a water-tube boiler operating at 125 lb. pressure. This pressure is reduced to 3 lb. at the boiler room and then passes through 100 ft. of 12-in. underground pipe to the building. Is this more economical than to operate at a boiler pressure of 3 lb.? If the high pressure is carried to the building and reducing valves placed at each floor, will the operation be more efficient?* A. R. W.

Ordinarily, there would be no gain in operating at 3 lb. pressure. While at present the steam, after the reduction to 3 lb. through the reducing valve, is at a temperature higher than it would be if the boiler pressure were 3 lb. (which increases the heat loss through the pipe insulation), this is offset by the fact that the steam is dry when flowing through the pipe, but with 3 lb. boiler pressure there would be considerable condensation.

If the radiators are now getting ample steam and the condensation is being trapped properly, there can be little if any advantage in placing reducing valves on each floor.

—❖—

WATER JET FROM AN ORIFICE—*If a vertical 6-in. water pipe under 300 lb. pressure has a 1-in. and a ¼-in. hole tapped in it, out of which orifice will the water get the greater horizontal distance.* T. B. R.

The distance a jet travels horizontally depends upon the velocity of the jet; but, in practice, air resistance and other factors slow up the velocity, so that the actual distance a jet will travel can be determined only by experiment.

The theoretical velocity in feet per second through the two orifices is the same, namely $V = \sqrt{2gH}$, but the actual velocity at the exit to the orifice is $V = C\sqrt{2gH}$, when C is the approximate coefficient, H = pressure head in feet and $g = 32.2$, the acceleration due to gravity. The actual value of C varies with the relation of orifice diameter to the water pressure. For example, under a 100-ft. head C for an orifice of .02 ft. dia., approximately ¼ in., is 0.593; while for an orifice diameter of .08 ft., approximately 1 in., the coefficient has a value of 0.592. This indicates that as the jets leave the orifice the ¼-in. one will have a velocity slightly greater than that of the 1-in. jet. But air resistance, etc., will probably more than offset this advantage, so that the 1-in. steam should be expected to travel a greater horizontal distance.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

AFTER rewinding a 75-hp. 2,500-r.p.m. shunt motor and putting it into service, difficulty was experienced with the bands heating. There are five bands made of steel wire equally spaced along the length of the armature, each band being about 1½ in. wide. I would like to know how to overcome this difficulty? D. L.

THE armature should be tested with the winding at operating temperature. Often an armature will test clear on the bench and yet show all the symptoms of short circuits when operating. This is caused by the centrifugal force moving the coils outward and eventually chafing the insulation sufficiently to permit a current to ground in one or more places. The ground contact may be within the bands themselves, which allows a heavy current to flow between the damaged coils. When the motor is shut down, and the armature is taken out and tested on the bench again the coils will have been pulled down into their slots and the grounds may not show up on test with a low voltage.

I know of one motor where the steel bands would snap after two or three hours' running because of the coils expanding from the normal operating temperature. That trouble was remedied by banding the armature with an alloy wire that had practically the same coefficient of expansion as copper.

CARL A. WAGNER.

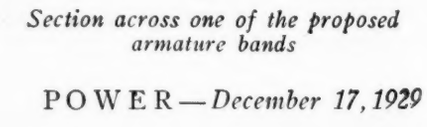
Denver, Colo.

—❖—

FROM the data given in "D. L.'s" letter, it would appear that the heating is due to eddy currents being set up in the solid wide bands. It is not stated whether the bands are insulated from the core iron. If not insulated, the omission would also be a contributing cause of the heating.

To reduce the heating, each 1½-in. band will have to be insulated from the core and divided into four sections, each section insulated from the adjacent one, as shown in the figure.

In putting on the sectional band use a good grade of 0.01- or 0.015-in. thick ¾-in. wide asbestos tape. Start the first section of the band in the same location on the core as the solid band was started. Put the tape against the core



Section across one of the proposed armature bands

and place 0.013-in. thick tinned sheet-steel clips, cut ½ in. wide x ⅞ in long, six inches apart for armatures below 24 in. diameter or eight inches apart for armatures above 24 in. diameter. Put on sufficient turns of wire to make a ⅜-in. wide band, turn up the clips and solder the one where the last turn ends, but do not cut the wire. After this has been done fold the tape tight against the band, as shown in the figure.

Start the second section of the band by putting tape on the core snug against the first section. Put the clips on as before but staggered from those in the first section. The tape and clips must be started under and held in place with the band wire, the tape being slit to make the crossover from section to section.

The crossover should be made as short as possible, and two clips should be placed at the start and finish of each section. Wind the sections as close together as possible, and put on four sections per band. Solder the bands all around, using a high-melting point solder, such as Westinghouse No. 35 alloy ribbon, or pure tin. After the bands are in place cut the tape off flush with the top of the bands.

Armature wire bands applied as outlined, with the sections of each band insulated from the core and adjacent sections, should give no serious trouble by heating.

A. C. Roe.
Wilkinsburg, Pa.

IF THE band wire is soldered in four or five places only, just enough to hold it securely, the trouble should disappear. In certain machines, a small voltage is induced in the band wires. If these wires are soldered into a continuous mass, the low resultant resistance will allow comparatively heavy eddy currents to circulate, often causing heat enough to melt the solder. The peculiar part is that, of two seemingly identical machines, one may have this trouble and the other may not. Our standard practice is to carefully note the position and amount of solder on all band wires before they are removed and to duplicate this on the finished job.

F. F. MacWilliams,
Power Department,
Pennsylvania Coal & Coke Co.
Cresson, Pa.

IN THE power house where I am employed we had some repairs made on an exciter generator by a local electrician. The bands were removed. When they were replaced steel wire was used. The exciter was put back in service and operated two days. When it was shut down the band wire was found broken in places around the armature, but the solder held the bands together. The wire was found to be brittle and easily broken. Brass wire was then used and we had no further trouble with the bands.

L. E. Schoonover,
Grasselli Chemical Co.
Niles, Ohio.

THERE are two sources of heat generation in the retaining bands of the motor, one due to hysteresis losses and the other to eddy currents. The only way to reduce the hysteresis loss is to employ banding wire of different magnetic properties. The eddy current loss, which is the main cause of heating, can be reduced to one-half by dividing each band into two equal parts separated from each other about $\frac{1}{16}$ to ⅛ in. The reason for the reduced heating is as follows:

Current flows around the section of band under a polepiece. The flow is determined by the voltage developed in the band and by the resistance of the path. By dividing the band, the voltage is halved and the resistance is practically unchanged, as the distance across the band is only a small fraction of the total length of path. The current, and therefore the heat, in each section will be halved. Care must be taken to insulate the bands from the armature core iron.

C. S. Collier.
Wilmington, Del.

A Question for Our Readers

OVERHEATING of a 4,000-kva. oil-insulated water-cooled transformer appears to be caused by fouled cooling coils. The cooling system recirculates water through a cooling tower and undoubtedly has a high salt concentration. The rated flow is 19 g.p.m. with a pressure of 25 lb., but with a pressure differential of 23 lb. across the coils the actual flow is only 10 g.p.m. Sludge removal by applying compressed air to the coils effects very slight improvement. What means may be employed to clean the coils without removing them? The coils are of brass.

K. T. S.

Suitable answers (of 200 words or less) from readers will be paid for and published in the Jan. 14, 1930, issue.

THE trouble is due to eddy currents. A 1½-in. band is much too wide for such a high speed motor. When an armature band of such a width is necessary it should be split up into three individual bands, each of a little less than one-third the width of the original band, with a space of about ⅛ in. between the sections. These individual bands should be provided with tinned iron clips, instead of copper, to increase the resistance to eddy currents. The bands should be held together with clips spaced 360 electrical degrees apart. Pure tin should be used for soldering, and used sparingly.

I have seen many jobs where the bands threw the solder, but they did not heat any more after the surplus solder had melted and was thrown off. Solder is of low resistance, and the more that is used the better the conducting path will be for the eddy current.

J. F. Wisinski,
Master Mechanic.
Belmont Copper Mining Co.
Superior, Ariz.

REGARDING the heating of bands on a 75-hp., 2,500-r.p.m., shunt-wound direct-current motor, it would be well to consider the action of the bands themselves. If a direct-current armature were to have a strap of sheet metal fastened around in the manner of an insulated band, and the armature revolved in a strong magnetic field, eddy currents would be generated in the sheet and it would heat. This is one reason why the armature core is laminated. Eddy currents are therefore the cause of this particular band trouble.

To eliminate the trouble place band clips under like poles only. In a four-pole machine there would be two clips per band equally spaced around the armature. In this way all clips on each band will at all times be under poles of the same polarity and the tendency to generate eddy currents in the bands will be small; therefore, heating at the bands will be slight.

E. J. Kelley,
Allis-Chalmers Mfg. Co.
Chicago, Ill.

THE trouble is no doubt due to eddy currents induced in the bands, which, being 1½ in. wide, form an excellent path for them. The trouble may be overcome by using narrow bands. I would suggest winding each in three sections of about ½-in. width, with an ⅛ in. space between sections, each section being clipped and soldered separately. Another method would be to make the bands 1½ in. wide but leave a space of approximately $\frac{1}{32}$ in. between turns and use one clip under each alternate pole. The clips must be equally spaced and the bands soldered at the clips only. I have had similar trouble with a number of armatures and have always been able to overcome it by these methods.

Andrew Walker,
Fred Thomson Co., Ltd.
Montreal, Canada.

PHOSPHO-BRONZE, or a good grade of bronze binding wire, should correct the trouble. The steel bands form a magnetic core, and the current generated is short-circuited by the copper strips put around them. It is possible to use steel wire, but in so doing it is better to have narrow bands

F. E. Brodie,
Brodie Light & Power Co.
Leesville, S. C.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

*Spot * News*

PRESIDENT HOOVER *in his annual message to Congress recommended that the three Cabinet officers now comprising the Federal Power Commission be replaced with full-time commissioners who could devote their entire attention to the growing responsibilities of the commission.*

* * *

ERECTION *of a large power station in Temesvar, Rumania, at a cost of* $5,000,000 *to* $6,000,000 *is planned by a special Rumanian company formed for the purpose through the co-operation of the A.E.G. of Germany. The company has secured a 60-year franchise for supplying electricity to the Banat and the control of a colliery to furnish fuel.*

* * *

SENATOR COUZENS *has stated informally he is now of the opinion that the regulation of interstate power should be omitted from his communications commission bill and be embodied in a bill enlarging the scope of the Federal Power Commission.*

* * *

THE WORLD'S LARGEST *water wheel is now being installed in the Spier Falls, N. Y., plant of the Mohawk Hudson Power Corporation. Adding 57,000 hp. to the capacity of the plant, the new unit will have penstocks 26 ft. in diameter, and will use, it is estimated, 4,000,000,000 gal. of water for a 24-hr. run.*

* * *

USE *of short-wave radio channels in emergencies, when all other means of communication are disabled, to communicate between power houses in the dispatching of electricity, was requested of the Federal Radio Commission recently by five public utility power companies.*

* * *

TOTAL MONTHLY *and average daily production of electricity by public utility power plants in October exceeded all previous records, with a total output of 8,685,000,000 kw.-hr., corresponding to an average output of 280,000,000 kw.-hr. a day, according to data recently made public by the Department of the Interior.*

Little Power Crosses State Lines, N. E. L. A. Investigation Shows

ONLY 10.73 per cent of the power consumed in the United States during 1928 crossed state lines, according to a study recently completed by the Statistical Research Department of the National Electric Light Association. The survey, which has been published as Statistical Bulletin No. 4 under the title of "Interstate Transfer of Electric Power in 1928," shows that 89.27 per cent of the total power consumed was produced in the state of consumption, and consequently was not involved in interstate commerce.

Analysis of the 10.73 per cent. or interstate power, shows that approximately two-thirds of it arose from the operation of 30 major generating plants separated from their normal power markets by state lines because of economic considerations or location of water falls. Designated in the report as "direct distribution," this power is generated in one state and distributed to consumers in another state by the same company at rates within the jurisdiction of the consumers' state.

The remaining one-third of the interstate power, designated as "wholesale transactions," is generated in one state and sold to another company in another state for distribution. These transactions are exclusively within federal jurisdiction so far as the direct regulation of the wholesale rate is concerned, although the rates that may be charged the ultimate consumer are subject to control by state authority.

The relative proportion of power in interstate movement to total consumption has increased from 8.99 per cent in 1926 to 10.73 per cent in 1928, the study shows. Practically all of this increase has been due to the placing in operation of three major developments during this time: Conowingo, Md.; Bellows Falls, Vt.; and Sterlington, La.

The study indicates that the distance traversed by the average kilowatt-hour in its path from power house to consumer in the United States is only about 22 miles. If the long-distance bulk transmissions of the Pacific Coast are excluded, the average distance traversed is only 18 miles.

Business Forecast

IN its issue of Dec. 18, the *Business Week* gives the following business outlook: "The highly concentrated seasonal slump and boom-reaction through which business is passing becomes sharper. Industrial activity in some lines is getting down to the frost-line, and primary distribution and general trade are tobogganing faster than usual.

"At the same time—on the principle that if winter comes spring can't be far behind—one can see the basis for early revival being laid. That basis is mostly psychological as yet—a total absence of any sign of fear-paralysis, and a universal and unseasonable strength of general building activity, the slight rise in unfilled steel orders, and the sustained level of coal production. We feel that, so far as industrial activity is concerned, the worst will be over in the next six weeks."

Charles Piez Chosen Head of Merchant Fleet

Charles Piez, president of the American Society of Mechanical Engineers and chairman of the Link-Belt Company of Chicago, has been selected for the presidency of the Merchant Fleet Corporation, according to a dispatch in the New York *Times* of Dec. 12.

The selection of Mr. Piez to head the Merchant Fleet Corporation, which operates the government fleets, is understood to have the approval of President Hoover, says the *Times* report. It is also said to be the first step in a movement on the part of the Shipping Board to consolidate the fleet activities and eventually to transfer the government vessels to private ownership and operation.

During the war, Mr. Piez served first as vice-president and general manager and later as director general of the emergency corporation which administered the government's huge shipbuilding program.

As president of the Merchant Fleet Corporation he will succeed T. V. O'Connor, chairman of the Shipping Board, who took over the presidency in 1927. Since that time Mr. O'Connor has filled both offices. Some time ago Chairman O'Connor is understood to have advised President Hoover that because of the strain upon his health he would like to be relieved of the double duty.

"West Alsek" Shows Saving on Second Voyage

Despite unusually heavy weather encountered 75 per cent of the time, the pulverized coal burner SS. "West Alsek" made a better showing on her second voyage than on her first one. She has recently completed a second round trip from New York to Glasgow, Avonmouth and other British ports, and return. All coal-burning machinery performed in a satisfactory manner during the voyage, and the installation has established itself as a thorough seagoing job.

Coal consumption eastbound averaged 417.1 lb. per mile, as compared with 449 lb. per mile on the first trip—a saving of 7.1 per cent. American coal was used, containing 14,015 B.t.u., 10.8 per cent ash and 31.6 per cent volatile matter per pound.

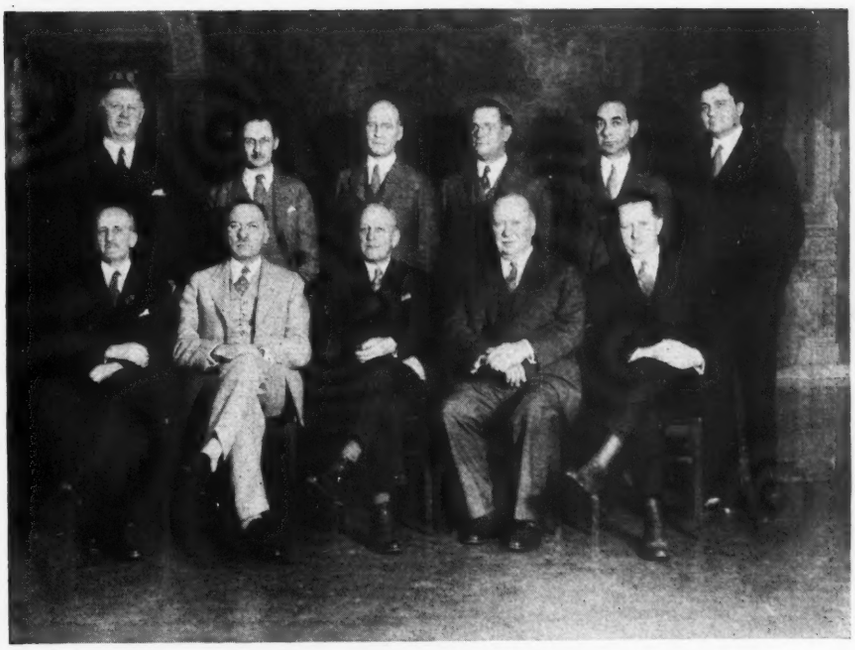
Westbound, the coal consumption, using a hard Scotch coal difficult to pulverize and burn, was 505.5 lb. per mile, an increase over that used on the first voyage. Taking into account the poor quality of the coal and the weather conditions, however, this was considered very good. This Scotch coal, containing 11,600 B.t.u., 17.3 per cent ash and 32.4 per cent volatile matter per pound, was burned alone without mixing it with better coal. Had the same quality been used on the westbound trip as on the eastbound, the consumption would have been 380.6 lb. per mile, a decrease of 15.2 per cent over the first round-trip average.

Heavy weather was encountered throughout three-quarters of the second round trip. The steamer, however, averaged 8.54 knots per hour, as compared with 9.58 on her first voyage with normal weather conditions. Revolutions of the engine were the same in both instances.

Co-operation, Keynote of P.T.A. Meeting

The need for co-operation among manufacturers of mechanical power transmission equipment was stressed at the annual meeting of the Power Transmission Association, held at the Hotel Commodore in New York City, Dec. 4. In presenting suggestions for the future operation of the association, President W. H. Fisher said, "Let every belting and power transmission manufacturer for the time being leave competitive discussion to sales work and unite upon a publicity program based on a single thought —the promotion of mechanical power transmission."

Reports of committees were read, reviewing various activities of the association during the year. It was brought out in one survey that 1929 sales will probably run 22.4 per cent ahead of those for 1928. George C. Miller, of the Dodge Manufacturing Company, was elected to fill a vice-presidential vacancy.



MEMBERS of the Advisory Committee of the Eighth National Exposition of Power and Mechanical Engineering held in Grand Central Palace, New York, Dec. 2-7. Sitting (left to right): Arthur J. Wood, Thornton Lewis, I. E. Moultrop (chairman of the committee), Fred Felderman, John H. Lawrence. Standing (left to right): Fred W. Payne, A. Black, David Moffatt Myers, F. M. Gibson, C. F. Hirshfeld, Charles F. Roth.

Operation of Muscle Shoals by Corporation Sought

Creation of a corporation for operation of the government properties at Muscle Shoals, Ala., is proposed in a resolution introduced by Representative Almon of Tuscumbia, Ala. It is along the lines of a resolution introduced in the Senate by Senator Norris, of Nebraska, on May 28, but with modifications with respect to the building of Dam No. 3 near Muscle Shoals and to the leasing of nitrate plants for 50 years.

In accordance with President Hoover's recommendations in his recent message to Congress, the Almon resolution changes the proposal in section 14 of the Norris resolution so as to declare it to be the government's policy to utilize the Muscle Shoals properties for "the manufacture of fertilizer and fertilizer ingredients" in peace time, instead of for "the fixation of nitrogen" for those purposes.

Contrary to the President's recommendation, however, the resolution would create the "Muscle Shoals Corporation of the United States," with a board of directors appointive by the President.

It proposes authority for appropriation of $10,000,000 for carrying out the Muscle Shoals program under the control of the board of directors, of which $2,000,000 would be immediately available for the construction of Cove Creek Dam, as also proposed by the Norris resolution. It has a new proposal, however, in addition to Cove Creek, for a similar $2,000,000 appropriation for construction of Dam No. 3 during the calendar year 1930.

Stetson Appointed Editor of Mechanical Engineering

Beginning with the December issue, George A. Stetson became editor of *Mechanical Engineering* and *Transactions* of the American Society of Mechanical Engineers.

Mr. Stetson was graduated in mechanical engineering from Sheffield Scientific School, Yale University, in 1910. For the next three years he was connected with a prominent New England manufacturing concern, and during that time gave much of his attention to technical publicity work, the preparation of articles for the engineering press, and to the revision of a treatise dealing with heating and ventilation. In 1913 he returned to Sheffield, where he became an instructor in power engineering and thermodynamics. In 1920 he was made assistant professor of mechanical engineering, which position he held until 1925, when he was appointed associate professor of heat-power engineering in New York University.

Mr. Stetson's connection with the publications of the society dates from 1918, when he became associated with *Transactions*, which work he carried on in parallel with his educational activities until 1928, when he resigned from the faculty of New York University to join the society's editorial staff.

News of Canada

Ontario to Buy 250,000 hp. from Beauharnois — Shawinigan Completes Surveys on St. Maurice River Project

ALL details have been worked out for an arrangement whereby power to be developed by the Beauharnois, Light, Heat & Power Company on the St. Lawrence River will be delivered to the Ontario Hydro Electric Power Commission. Only the actual signing of the contract and its ratification remain to be accomplished.

The contract will be one of the most important ever entered into in Canada for the supply of hydro-electric power. Under its terms the Province of Ontario will secure one-half of the power developed at the Beauharnois site, up to a total of 250,000 hp. at $15 per horsepower. This power will be for distribution over the lines of the Ontario Hydro-Electric Power Commission. The contract ranks in size with that negotiated about three years ago with the Gatineau Power Company for 260,000 hp. for distribution in Ontario. The first of the power will be delivered in 1931. Delivery of the power will be made by the company at the interprovincial boundary. The details of construction are not yet fully worked out, but it is understood the commission will erect a line from the boundary to the present Gatineau line, a distance of about 40 miles.

Shawinigan Completes Surveys

Surveys on the upper reaches of the St. Maurice River, in the Province of Quebec, are now completed, and the Shawinigan Water & Power Company is ready to take the first step in power development on that section of the river, which will give it an additional ultimate installation of 600,000 hp. The first development will likely take place at Rapide Sans Nom, where a plant will be built to generate 100,000 hp. At a preliminary estimated cost of $80 per horsepower, this development will involve an outlay of some $8,000,000. Later on other plants will be built at Rapide Blanc, Rapide des Coeurs and Rapide Allard.

Under the terms of the agreement with the Quebec government, the company obtained a 75-year lease of all the power sites formed by the rapids in the St. Maurice River above La Tuque. The agreement provides that construction operations on the first development will be commenced by July 1, 1930, 100,000 hp. to be developed by July 1, 1933. The company must also carry out succeeding developments so that the fourth will be started by July 1, 1938. Shawinigan's present program calls for the installation of about 700,000 hp. over the next nine years. In addition to the 600,000 hp. to be developed on the upper St. Maurice, there will be installed in 1930 100,000 hp. at the three existing plants.

Coming Conventions

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

Obituary

HENRY ADAMS, consulting engineer, president of the board of managers of the Maryland Institute, and organizer of the mechanical department of the supervising architect of the United States Government, died Dec. 9 at his home in Baltimore, Md. Mr. Adams was born on Feb. 11, 1858, in Duisburg, Germany. Coming to Baltimore he opened an office as consulting engineer, in which capacity he designed and supervised the installation of mechanical equipment in many of the largest buildings in the city. During the war, Mr. Adams was engineer of the Federal Fuel Administration for Maryland and Delaware. He was a member of the American Society of Mechanical Engineers.

WALLACE W. BRIGGS, since 1925 vice-president and general manager of the Grays Harbor Railway & Light Company, Aberdeen, Wash., died in that city Dec. 9. For a number of years he was San Francisco district manager for the Westinghouse Electric & Manufacturing Company and later general manager of the Great Western Power Company of California. In 1918 he moved to the East to join the Westinghouse New York organization and subsequently became affiliated with the Federal Light & Traction Company, which controls the Grays Harbor company. Mr. Briggs was sent from New York to assume the executive duties of vice-president and general manager in Aberdeen. At the time of his death he was a member of the executive committee of the Northwest Electric Light & Power Association.

WILLIAM A. BRACKENRIDGE, retired senior vice-president of the Southern California Edison Company, died Nov. 29 at Santa Barbara, Calif., after a lingering illness. He was 71 years of age. Before joining the Edison company, Mr. Brackenridge was associated with the board of consulting engineers that conceived the Niagara Falls water power development plan, and was in charge of construction for the Niagara Falls Power Company.

Personals

ALEX DOW, president of the Detroit Edison Company, was recently awarded an honorary membership in the National District Heating Association at a dinner given in his honor in Detroit. It was conferred upon him at a meeting of the association last June, while he was traveling in Europe.

R. B. BOALS, professor of mechanical engineering at Oregon State College, has resigned to accept the position of city engineer in charge of power plant and water system of the City of Fairbury, Neb.

J. H. MANNING, president of the Stone & Webster Engineering Corporation, and G. H. CLIFFORD, president of the Stone & Webster Service Corporation, have been elected to the board of directors of Stone & Webster, Inc.

C. W. DE FOREST, formerly vice-president of the Union Gas & Electric Company, Cincinnati, in charge of engineering and electrical operation, is now chief engineer in charge of electrical engineering for the Columbia Engineering & Management Corporation. Mr. De Forest has supervised the design and construction of many power plants, among which are the West End and Columbia power stations in Cincinnati. He is the author of several papers on engineering subjects and is active in association work, being a member of the A.S.M.E. and chairman of the committee on power generation of the Association of Edison Illuminating Companies.

J. H. ANDERTON has been elected president of Thebo, Starr and Anderton,

Inc., engineers and constructors of San Francisco, Calif., to succeed F. M. THEBO, who retired on Nov. 1.

E. O. SHREVE, manager of the industrial department of the General Electric Company, has been made assistant vice-president on the staff of Vice-President J. G. Barry, according to an announcement of Gerard Swope, president of the company. William W. Miller, business manager of the industrial department, has been made manager to succeed Mr. Shreve.

DR. IRVING LANGMUIR, associate director of the research laboratory of the General Electric Company and president of the American Chemical Society, has been awarded the Chandler medal for achievement in science by Columbia University.

WILLIAM J. BUSH resigned recently from the B. F. Sturtevant Company, with which he has been located at Birmingham, Ala., as district manager, to take a position as building service engineer in the structural divison of the Stone & Webster Engineering Corporation at Boston.

BUSINESS NOTES

WARREN STEAM PUMP COMPANY, Warren, Mass., announces the appointment of the Tennant Company of Houston, Texas, to handle its line of pumping machinery in the southern half of that state.

LINDE AIR PRODUCTS COMPANY, New York City, announces the opening of a new oxygen plant at 60 Knott St., Portland, Ore., with A. D. Davis as superintendent.

R. H. BEAUMONT COMPANY, Philadelphia, Pa., has transferred H. S. Ford, eastern sales manager of the company, to the New York office at 50 Church St. Mr. Ford in conjunction with H. W. Ruth of that office will handle all sales matters in the New York district. H. B. Mosley, formerly New York manager of the Beaumont Manufacturing Company, a division of the R. H. Beaumont Company, is now connected with the Philadelphia office of the latter company.

ALEXANDER MILBURN COMPANY, Baltimore, Md., announces that Charles P. Clampitt has been placed in charge of its Chicago office at 220 S. State Street.

LINK-BELT COMPANY, Chicago, Ill., announces the appointment of J. J. Hartley to the position of chief engineer of the company's Pershing Road plant. He was formerly in charge of the foundry equipment sales department in the western division of the Link-Belt organization. W. L. Hartley, brother of "J. J.," succeeds him as manager of the department.

With the Society Sections

A.S.M.E., Providence Section. Joint meeting with the Power Section of the Providence Engineering Society in the society rooms, Jan. 7, 1930, at 8 p.m. Subject: "Economics of New England from an Engineer's Point of View," by Harry A. Westcott, of Westcott & Mapes, consulting engineers, of New Haven, Conn.

A.S.M.E., Rochester Section. Joint meeting with the Rochester Engineering Society and the Buffalo section of the A.S.H.&V.E. at the Sagamore Roof, Dec. 19, at 8:15 p.m., preceded by an informal dinner at 6:15 p.m. Subject: "Production of Steam and Electricity for a Factory District," by George C. Van Vechten and Charles C. Fairfax, both of the Stecher Lithograph Company. Visiting members of the A.S.H.&V.E. will make plant inspection trips in the afternoon.

Boston Society of Civil Engineers. Buffet supper and meeting, Dec. 18, at 6:15 p.m., at Tremont Temple. Subject: "Hydraulic and Mechanical Features of the Bellows Falls Hydro-Electric Plant," by Edwin A. Dow, designing engineer of the New England Construction Company.

Boston Plant Engineers' Club. Meeting and dinner, Dec. 18, at 6:30 p.m., the University Club. Subject: "Design and Lubrication of Bearings," by Prof. Arthur E. Norton, of Harvard Engineering School.

TRADE CATALOGS

WELDING—St. Paul Welding & Manufacturing Company, 174 West Third St., St. Paul, Minn., has issued recently a folder describing and illustrating its kerosene burners for preheating heavy pieces of metal before welding.

PURIFIERS — Centrifix Corporation, 3029 Prospect Ave., Cleveland, Ohio, has published a new 8-page bulletin, No. 153, describing and illustrating the application and principle of operation of internal steam purifiers for stationary boilers. The bulletin also gives information on additional types of purifying and separating equipment as developed by this company.

PUMPS—Bulletins 412, 413 and 414 published by the Economy Pumping Machinery Company, 3431 West 48th Pl., Chicago, Ill., describe horizontal and vertical centrifugal pumps for sewage disposal, multi-stage centrifugal pumps for boiler feeding, and sump pumps, respectively.

METALLURGY—Spectrographic outfits for metallurgical analyses are described in a recent catalog of Adam Hilger, Ltd., 24 Rochester Place, Camden Road, London, N.W.1. Issued by the same firm is "The Practice of Spectrum Analysis with Hilger Instruments," which sells for 1s. 6d.

MONEL METAL — "Modern Power Plant Equipment" is the title of a 48-page bulletin just issued by the International Nickel Company, 67 Wall St., New York City. Profusely illustrated, it contains an interesting article on the history of power, one on the characteristics of monel metal in power plant equipment, and data on the properties of monel metal.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.20 @$2.35
Kanawha.....	Columbus.....	1.30 @ 1.60
Smokeless.....	Cincinnati.....	2.00 @ 2.20
Smokeless.....	Chicago.....	2.25
S. E. Kentucky...	Chicago.....	1.35 @ 1.60
Steam.....	Pittsburgh.....	1.50 @ 1.60
Gas Slack.....	Pittsburgh.....	1.00 @ 1.15
Big Seam.....	Birmingham....	1.25 @ 1.50
Anthracite		
(Gross Tons)		
Buckwheat.....	New York.....	$2.50
Barley.....	New York.....	1.35@ 1.50

FUEL OIL

New York—Dec. 12, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Dec. 4, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.646 per bbl., or 42 gal.; 26@28 deg., $1.696 per bbl.; 28@30 deg., $1.746 per bbl.; 30@32 deg., $1.796 per bbl.; 32@36 deg., gas oil, 4.651c. per gal.; 37@40 deg., distillate, 5.73c. per gal.

Pittsburgh—Dec. 3, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.25c. per gal.

Philadelphia — Dec. 3, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — Dec. 10, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Dec. 6, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.02½@$1.07½ per bbl.; 30@32 deg., $1.22½ per bbl.

Boston—Dec. 9, tank-car lots, f.o.b., 12@14 deg., Baumé 4.25c. per gal.; 28@32 deg., 5.75c. per gal.

Dallas—Dec. 7, f.o.b. local refinery 26@30 deg., $1.35 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., San Diego—G. B. McDougall, Sacramento, State Archt., will receive bids until Dec. 24 for the construction of a power house with 70 ft. stack here for San Diego State Teachers College. Estimated cost $37,500.

Conn., Hartford—Terry Steam Turbine Co., Windsor St., awarded contract for the construction of a boiler house to A. F. Peaslee Co., 15 Lewis St. Estimated cost $40,000.

Ill., Chicago—Holabird & Root, 333 North Michigan Ave., Archts., will receive bids until Dec. 19 for the construction of a 40 x 80 ft. electric sub-station at 127 North Dearborn St. for Commonwealth Edison Co., 72 West Adams St. Estimated cost $500,000.

Ind., Knightstown—Indiana Soldiers & Sailors Orphans Home, L. A. Cortner, Supt. will receive bids until Dec. 30 for the construction of a power house and laundry including equipment. Estimated cost $200,000. McGuire & Shook, 941 North Meridian St., Indianapolis, are architects.

Ky., Lexington — U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., will receive bids until Jan. 14 for the construction of a group of buildings including boiler plant, refrigeration and ice making plant, electric elevators, etc. at U. S. Veterans' Hospital here.

La., New Orleans—Sewage & Water Board G. G. Earl, Supt., will receive bids until Jan. 24 for construction of drainage pumping station 9 and extension to station 2; to include one 3,000 kva. 3 ph., 25 cycle water cooled conservator type 6,800-3,500 v. transformer, lift screen, etc. in connection with sewage treatment works.

La., St. Martinsville—City voted $38,000 bonds for filtration plant and power plant in connection with waterworks.

La., West Monroe—American Service Co., M. Sanders, Mgr., is having preliminary plans prepared for the construction of an ice plant at 5th and Coleman Sts. Estimated cost $100,000.

Md., Baltimore—Mayor and City Council, City Hall, received lowest bid for the construction of a 35 x 65 ft. pumping station at Underwood Rd. and Spring Lane from McCall & Watts, 3404 Marmon Ave. $86,250.

Mass., Allston (Boston P. O.)—Boston & Albany R.R. Co., South Station, Boston, awarded contract for the construction of a 1 and 3 story power house to include two 450 hp. Sterling boilers, coal conveyors, pulverizers, etc. at Beacon Park here to J. F. Fitzgerald Construction Co., 38 Chauncy St., Boston. Estimated cost $225,000.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., plans the construction of a steam heating plant at Kneeland and Utica Sts. I. E. Moultrop, c/o owner, is engineer.

Mass., North Reading—Dept. of Public Health, plans reconstruction and remodeling of power house at State Sanatorium. Estimated cost $40,000. Private plans.

Mass., Worcester—Walker Coal & Ice Co., 102 Thomas St., awarded contract for the construction of an ice manufacturing plant and storage building on Chadwick Sq. to E. D. Ward Co., 82 Foster St.

Mich., Monroe—Holabird & Root, 333 North Michigan Ave., Chicago, Ill., awarded contract for the construction of a 4 and 12 story hotel on Elm St. to J. W. Butler Construction Co., 1300 Free Press Bldg. Owner's name withheld. Steam heating and refrigeration systems, boilers, elevators, etc. will be installed.

Mich., River Rouge — Ford Motor Car Co., Coolidge Highway, Dearborn, will soon award contract for the construction screen house for power plant intake tunnel, here. Giffels & Vallet, 604 Marquette Bldg., Detroit, are engineers.

Miss., McComb—Southern United Ice Co., will build a 1 story, 64 x 100 ft. ice storage warehouse and docks. Estimated cost $175,000. Work will be done by local labor.

Neb., Sutton—City will soon receive bids for rebuilding electric distribution system from direct to alternating system including thirty-three secondary transformers with hangers and primary cutouts 3 kva. 2200 v. to 37½ kva; one 10 kva. 6.6 amp. series regulator station type, 530 service meters, one 8 panel switchboard, etc. Estimated cost $30,973. Hennington Engineering Co., 326 Union State Bank Bldg., Omaha, is engineer.

N. J., Atlantic City—City, c/o L. I. Brooks, 65 Madison Ave., New York, N. Y., Archt., is having plans prepared for the construction of a 20 story hotel including steam heating and ventilation systems, boilers, elevators, etc. Mississippi Ave. and Boardwalk here. Estimated cost $1,000,000.

N. J., East Paterson—Bd. of Council, Boro Hall, awarded contract for the construction of a sewage disposal plant and pumping station to Kucher Bros., Montvale, N. J. $192,690.

N. J., New Brunswick—J. L. Mott, 31 Morgan Ave., Brooklyn, N. Y., is having preliminary plans prepared for the construction of a 14 story office building, including steam heating system, etc. on Livingston Ave. Estimated cost $1,000,000. G. E. Fulton Jr., 19 West 44th St., New York, is architect.

N. Y., Brooklyn—Rubel Coal & Ice Co., 937 Fulton St., will receive bids about Jan. 15 for addition to ice manufacturing plant at India Wharf and Conover St. Estimated cost $40,000. H. J. Nurick, 44 Court St., is architect.

N. Y., New York—Bd. of Higher Education, awarded contract for the construction of a power house, etc. at Hunter College, Bedford Park Blvd. Strong St. and Goulden and Jerome Aves. to J. T. Brady Co., 103 Park Ave. Estimated cost $795,000.

Okla., Blackwell—City awarded contract for a new 250 kw. steam turbine and generator unit to Westinghouse Electric & Mfg. Co., Chamber of Commerce Bldg., Pittsburgh, Pa. Estimated cost $75,000.

Okla., Weleetka—Public Service Co., 510 South Boston St., Tulsa, is having plans prepared for a 15,000 kw. addition to plant here also 66,000 v. transmission line from Weleetka to West Tulsa. Estimated cost $350,000. Private plans.

Texas — West Texas Utilities Co., Abilene, plans to expend $5,000,000 in 1930 for etension and construction program in West Texas. Plans include power lines, pipe lines, distribution systems in various towns, construction of power units, etc. Private plans.

Tex., Austin—City c/o A. R. Johnson, Mgr., awarded contract for the construction of three sub-stations, one near municipal power plant, one in North Austin and third in East Austin to U. G. I. Contracting Co., 112 North Broad St., Philadelphia, Pa. Estimated cost $200,000.

Tex., Lubbock—Texas Techological College, plans extensions and improvements including waterworks well and heating plant addition. Estimated cost $35,000.

Tex., Paris—City accepted tenative bids from Fairbanks-Morse Co., 900 South Wabash Ave., Chicago, Ill. for the construction of entire light and power plant. Estimated cost $400,000.

Ont., London—Utilities Commission, plans extensions and improvements to waterworks including new pumping station, additional mains, etc. Estimated cost $200,000. E. V. Buchanan, c/o owner, is engineer.

Ont., Windsor—Essex Border Utilities Comn., plans additions to filtration plant; increase filter bed area, tripple reservoir capacity and double present pumping capacity etc. Estimated cost $554,000. J. C. Keith, c/o owner, is engineer.

Ont., York—Grinshaw Bros., 20 Bleeker St., Toronto, plans the construction of a 10 unit apartment building including steam heating and refrigeration systems, etc. here. Estimated cost $1,000,000. Private plans.

Equipment Wanted

Blowers, Pumps, Switchboards, Etc.—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Dec. 26 for blowers, pumps, switchboards, etc.

Boilers, Superheaters, Blowers, Etc.—Lincoln, Neb.—City, T. H. Berg, Clk. City Hall, will receive bids until Dec. 20 for power plant equipment including two 500 hp. water tube boilers, two superheaters, two soot blowers, two 2 in. copes or equal feed water regulators, two stokers and economizer.

Boiler—College Station, Tex.—A. & M. College, B. D. Marburger, Supt. of Utilities, will receive bids until Dec. 24 for one 500 hp. horizontal boiler, 250 lbs. steam pressure at 150 degree superheat.

Pump and Motor—Minneapolis, Minn.—City will receive bids until Dec. 20 for a 40 m. gal. pump and 600 hp. motor for proposed waterworks.

Pump and Motor—Geary, Okla.—Geary Ice Co., G. A. Critchfield, Supt., is in the market for a 125 g.p.m. centrifugal pump and 5 hp. motor for ice plant.

Pumps, Etc.—St. Clair Shores, Mich.—City, C. Dederich, Clk., plans to purchase motor driven centrifugal pumps, etc. for proposed sewage pumping station on Nine Mile Rd. Estimated cost $30,000.

Pumps, Etc.—Ocean Grove, N. J.—City plans the installation of pumps, etc. in connection with sewage treatment plant.

Pumps, Etc.—Purcell, Okla.—City plans to purchase pumps, etc. for proposed waterworks system. Estimated cost $25,000.

Pumps, Etc.—Tecumseh, Okla.—City, H. C. French, Clk., will receive bids until Dec. 20 for motor driven centrifugal pumps, etc. for proposed waterworks improvements. Estimated cost $120,000.

Pumps, Etc.—Westboro, Ont.—City plans to purchase centrifugal pumps, etc. for proposed waterworks system. Estimated cost $235,000.

Pumping Equipment—Sapulpa, Okla.—City plans the installation of Diesel engine pumping equipment for proposed waterworks. Estimated cost $35,000.

Industrial Projects

Conn., New Haven—G. & O. Mfg. Co., 138 Winchester Ave., is receiving bids for the construction of a 2 story, 40 x 100 ft. factory for the manufacture of airplane radiators on Winchester Ave. Estimated cost $40,000. Westcott & Mapes, 139 Orange St., are architects.

Ill., Chicago—F. D. Chase Inc., 720 North Michigan Ave., Archt., will receive bids after Jan. 1 for the construction of a 1 and 2 story factory at California Ave. and 50th St. for United Autographic Register Co., 2316 West 43rd St. Estimated cost $1,000,000.

Ind., Fort Wayne—Fort Wayne Milling Co., awarded contract for the construction of a 60 x 250 ft. rolling mill plant at 1701 McKinley St. to Rochester Bridge Co., Rochester. Estimated cost $50,000.

Ind., Mishawaka — Duratile Corp., awarded contract for 50 x 100 ft. factory at 227 North Mill St. to P. Schumaker, 323 West 4th St., Estimated cost $43,000.

Mich., Coldwater—Homer Furnace Co., is having plans prepared for the construction of a 1 story furnace factory. Estimated cost $150,000. Private plans.

Mich., Detroit—Bellevue Industrial Furnace Co., 2971 Bellevue Ave., is having plans prepared for a 1 story, 85 x 165 ft. addition to furnace factory. Estimated cost $45,000. C. L. Phelps, 503 Detroit Savings Bank Bldg., is architect. Electric motors, etc. will be required.

Mich., Detroit—C. W. Brandt, 2111 Woodward Ave., Archt., will receive bids about Dec. 19 for the construction of a 1 story, 60 x 400 ft. steel mill on Fireman Ave. for Bopp Steel Co., 4-237 General Motors Bldg. Equipment for the manufacture of steel sheets and strips will be required.

Mich., Detroit—Michigan Leather Packing Co., 548 East Fort St., is having plans prepared for the construction of a 1 story, 75 x 310 ft. leather products factory on Freeland Ave. Estimated cost $60,000. Private plans. Electric motors and leather working machinery will be required.

Mich., Monroe—Detroit Stoker Co., 3-120 General Motors Bldg., Detroit, awarded contract for the construction of a 1 story, 60 x 180 ft. stoker factory here to Austin Co., 11-205 General Motors Bldg. Estimated cost $40,000. Electric motors and miscellaneous equipment for the manufacture of stoker parts will be required.

Minn., Blue Earth—Minnesota Valley Canning Co., is having plans prepared for addition to canning plant including new power plant. Estimated cost $450,000. R. W. Richardson, 116 East 4th St., St. Paul, is engineer.

O., Dayton—The Brownell Co., 1204 North Findley St., plans a 2 story addition to factory for the manufacture of boilers and stokers. Estimated cost $500,000. Geyer & Neuffer, Ludlow Arcade, is architect.

Pa., Falls Creek—J. H. France Refractories Co., J. H. France, in charge, Snow Shoe, Pa., will soon award contract for the construction of a refractories plant including 100 x 460 ft. kiln building, 20 x 60 ft. press building, 60 x 80 ft. bin storage building, 30 x 30 ft. mixer room, 400 ft. continuous kiln, 300 ft. dryer and refractories equipment in Clearfield Co. Estimated cost $350,000. Private plans.

Ont., St. Catharines—Packard Electric Co., F. Wyman, Mgr., Race St., plans the construction of a new factory. Estimated cost $100,000.